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**Meteorological Atlas of  
the Southern Hemisphere  
Lower Stratosphere for  
August and September 1987**

**P. A. Newman, D. J. Lamich, M. Gelman,  
M. R. Schoeberl, W. Baker, and A. J. Krueger**

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Lower Stratosphere for  
August and September 1987**

P. A. Newman  
*Applied Research Corporation*  
*Landover, Maryland*

D. J. Lamich  
*Sigma Data Services Corporation*  
*Rockville, Maryland*

M. Gelman  
*National Meteorological Center*  
*Washington, D.C.*

M. R. Schoeberl, W. Baker,  
and A. J. Krueger  
*Goddard Space Flight Center*  
*Greenbelt, Maryland*



National Aeronautics  
and Space Administration

Scientific and Technical  
Information Division

## **1. INTRODUCTION**

The purpose of this atlas is twofold. Its primary purpose is to provide a meteorological background to the 1987 Antarctic ozone hole. The airborne experiment using NASA's ER-2 and DC-8 based at Puntas Arenas, Chile, and the National Ozone Experiment II at McMurdo, Antarctica have provided a wealth of new information on the polar stratosphere over Antarctica. The intent of this atlas is to provide experimenters with both a cross check on their results, and a global perspective with which to view those results.

The secondary purpose of this atlas is to provide the atmospheric community with data for general meteorological and pedagogical purposes. It is hoped that these fields will stimulate investigations on some of the lower stratospheric transport and dynamical processes.

## **2. DATA DESCRIPTIONS**

### **A. Total Ozone Mapping Spectrometer (TOMS)**

The total ozone fields are obtained from the gridded analyses of the Total Ozone Mapping Spectrometer (TOMS). The TOMS instrument is aboard the Nimbus-7 satellite. This satellite is a sun-synchronous polar orbiter (~14 orbits/day) with a near local noon equator crossing. TOMS is a cross-course scanning instrument which samples backscattered radiation at six wavelengths (312.5, 317.5, 331.2, 339.8, 360, and 380nm). The cross nadir scan is sequentially performed in three degree steps from  $\pm 51^\circ$ , producing 35 total ozone measurements over a 2800km line approximately perpendicular to the sub-orbital track. The resolution ranges from approximately 50km at nadir to 200km at the  $\pm 51^\circ$  scan points (~1400km to the

left/right of the sub-orbital track). The TOMS scanning capability in conjunction with ~14 orbits/day yields global daily total ozone pictures. The data are averaged into 2° latitude by 5° longitude grids.

#### B. National Meteorological Center data (NMC)

The National Meteorological Center (NMC) data used here consist of tropospheric fields from 1000 mb to 100 mb and stratospheric grids from 70 mb to 0.4 mb. The fields from 1000 mb to 100 mb are the 1200 GMT daily global operational analyses described by McPherson et al. (1979). These tropospheric analyses result from optimal interpolation of radiosonde observations (RAOBS) and NOAA-10 satellite temperature retrievals with first-guess fields provided by the NMC prediction model. The stratospheric data developed by the NMC Climate Analysis Center are 1200 GMT operational analyses at the 70-0.4 mb pressure levels, produced from satellite temperature retrievals via a modified Cressman analysis (Gelman et al., 1987). The retrieval of temperatures from NOAA-10 satellite TIROS Operational Vertical Sounder (TOVS) (see Smith et al., 1979 for a description of the TOVS instrument) radiances is performed by co-locating a number of radiosonde and rocketsonde observations with radiance positions, followed by the production of a set of linear multiple regression coefficients. These regression coefficients are then applied to the radiance measurements to produce a complete set of layer mean temperature retrievals. The regression coefficients are divided into five climatic zones corresponding to north and south polar regions, north and south midlatitudes, and the equatorial region. Because RAOBS are available below 10 mb, the regression coefficients are updated on a 1 to 4-week basis for the 70-10 mb layers, whereas the 5-0.4mb coefficients are constant. Thus, for Antarctic radiances, a single set of regression coefficients is applied to the radiances, and these coefficients have an

average lag of 2½ weeks with the analysis below 10 mb (Phillips et al., 1979).

Hence, the NMC analyses below 10 mb are not independent of RAOBS. It is important to note, however, that the NMC data are independent of ozone, since the TOVS High-Resolution Infrared Sounder channel 2 (9.6um) which is sensitive to ozone, is not utilized in the temperature retrievals (Smith et al., 1979).

### C. Goddard Laboratory for Atmospheres data (GLA)

The Goddard Laboratory for Atmospheres (GLA) has produced a set of gridded global analyses for the Antarctic Ozone Experiment. The GLA Forecast-Analysis-Retrieval System analyzes pressure at sea level, while geopotential heights, winds and relative humidities are analyzed on 12 mandatory upper air pressure levels between 1000 mb and 50 mb. The horizontal resolution used was 4° in latitude by 5° in longitude with analyses being produced every six hours. The GLA system consists of three components: an objective analysis scheme, a general circulation model and a satellite temperature retrieval scheme.

The successive correction method (SCM) analysis scheme as described in Baker (1983) was used. Conventional pressure level data and retrieved layer thicknesses are checked for quality and compared to first guess information derived from a six hour model prediction. Those data that pass these quality and consistency checks are then used in an iterative interpolation process to define the analysis values at the grid points. For this interpolation, the data are weighted according to their distances from the grid points and the relative accuracies of the various measuring instruments.

The model employs a fourth order, energy conserving, horizontal finite difference scheme and nine equally spaced vertical sigma layers between 10 mb and the surface. A 16th order Shapiro filter is applied every two hours to the sea

level pressure, upper air wind and potential temperature fields. During the assimilation cycle, the model uses a Matsuno time differencing scheme to control small scale noise introduced by imbalances in the analyzed fields. No dynamic or normal mode initialization is performed on the analyzed fields before they are used by the model to start the next six hour forecast segment. A complete description of the model and its physical parameterizations can be found in Kalnay et al. (1983) and Kalnay-Rivas et al. (1977).

A unique feature of the GLA system is the interactive use of the GLA Physical Inversion Retrieval Scheme within the data assimilation cycle. Beginning with a first guess temperature field from the model forecast, the retrieval scheme inverts the radiance data from the HIRS2 and MSU instruments to produce temperature profiles at the sounding locations. These temperatures are then converted to layer thicknesses and passed to the SCM for analysis along with all other available data. The interactive nature of this procedure ensures that the retrieval scheme always starts with a physically realistic first guess. The resulting improvements in the accuracy of the temperature profiles benefit the analysis. The GLA physical retrieval system is described in Susskind et al. (1984).

For the duration of the Antarctic Ozone Experiment, the National Meteorological Center (NMC) generously provided GLA with daily dumps of their global level 2a data and level 1b HIRS2 and MSU radiance data. The level 2a data consist of all observations that contribute to NMC's Global Data Assimilation System (GDAS). These data contain rawinsonde reports, wind reports from aircraft and pilot balloons, and cloud track winds from NESS and the European Space Agency (ESA) that have been checked for quality and accuracy by NMC's data preprocessing algorithms.

### 3. FIGURES

Each day (1 August 1987 to 30 September 1987) consists of a set of 7 plots on two separate pages. The first page has polar stereographic projections of NMC 200-100mb vertically averaged temperature (thicknesses), TOMS total ozone, NMC 100mb zonal mean perturbation heights, and 420 K Ertel's potential vorticity (Epv). The second page has a polar stereographic plot of GLA 200-100mb vertical mean temperature; a polar stereographic plot of NMC 50-30mb vertical mean temperature; a 65°W latitude/height cross section of Epv and potential temperature; a 65°W latitude/height cross section of geostrophic isotachs and temperature; and a 65°S longitude/height cross section of geostrophic wind vectors and temperature.

The vertical mean temperatures are derived from the geopotential height thicknesses according to,

$$\langle \bar{T} \rangle = \frac{g}{R} (Z_2 - Z_1) / \ln(p_2/p_1) \quad (1)$$

Here,  $Z_1$  ( $Z_2$ ) is the geopotential height at a pressure  $p_1$  ( $p_2$ ),  $R$  is the gas constant for dry air, and  $g$  is  $9.81 \text{ m}^2/\text{s}$ . The Epv is calculated from,

$$Q = -g (\xi + f) \frac{\partial \theta}{\partial p} \quad (2)$$

Here,  $Q$  is Epv,  $\xi$  is the relative vorticity,  $f$  is the planetary vorticity, and  $\theta$  is the potential temperature. The NMC height fields have been smoothed horizontally in order to facilitate Epv plot interpretation, but the planetary and medium scale features are largely unaffected. Typical mid-latitude values for the quantities in (2) are  $10^{-4} \text{ 1/s}$  for the absolute vorticity, and  $10^{-2} \text{ }^\circ\text{K m}^2/\text{kg s}$  for the pressure derivative of potential temperature at  $420 \text{ }^\circ\text{K}$ . Therefore,  $Q$  is on the order of  $10^{-5} \text{ }^\circ\text{K m}^2/\text{kg s}$ , hence, in the polar stereographic figure, one Epv unit is  $10^{-5} \text{ }^\circ\text{K m}^2/\text{kg s}$ .

## REFERENCES

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## FIGURE CAPTIONS

### First Page

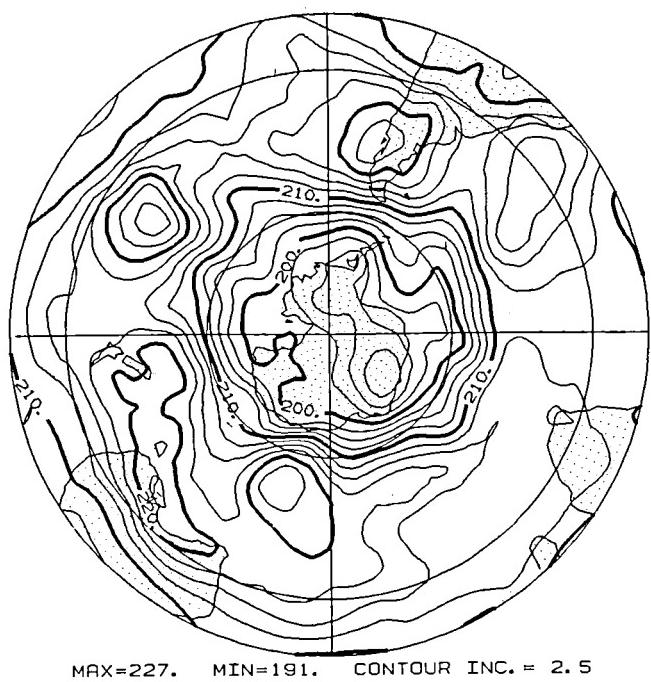
- Top left: NMC 200-100 mb vertical mean temperature (thicknesses) on a polar stereographic projection. The maximum, minimum and contour increment are noted on the figure base. The outer circle corresponds to 20°S, with additional latitude circles at 30 and 60°S. The prime meridian is to the right of the figure.
- Bottom left: As in top left, but for 100mb perturbation heights. Units are geopotential meters.
- Top right: As in top left, but for TOMS total ozone.
- Bottom right: As in top left, but for 420°K Epv. Units are  $10^{-5} \text{ } ^\circ\text{K m}^2/\text{kg s}$ . Shading is between 1.5 and 2.

**Second Page**

- Top left: GLAS 200-100mb vertical mean temperature (thicknesses) on a polar stereographic projection. The outer circle corresponds to 20°S, with latitude circles at 30 and 60°S. The prime meridian is to the right of the figure.
- Bottom left: As in top left, but for NMC 50-30mb vertical mean temperature (thicknesses).
- Top right: 65°W Latitude/height cross section of potential temperature (dashed lines, 50°K contour increment), and Epv (solid line, units of  $10^{-7}$  °K m<sup>2</sup>/kg s). An Epv value of 100 corresponds to  $10^{-5}$  °K m<sup>2</sup>/kg s. The Epv has a contour increment of 30 for values below 300, and a contour increment of 300 for values above 300.
- Middle right: 65°W latitude/height cross section of geostrophic isotachs (solid lines, 10 m/s contour increment), and temperature (dashed lines, 5°K contour increment).
- Bottom right: 65°S longitude/height cross section of geostrophic wind vectors and temperature (5°K contour increment). The vector orientation shows a westerly vector pointing to the right, and a southerly pointing upward. A 100m/s westerly wind is denoted at the bottom right, below the longitude axis. Note: a westerly blows from west to east.

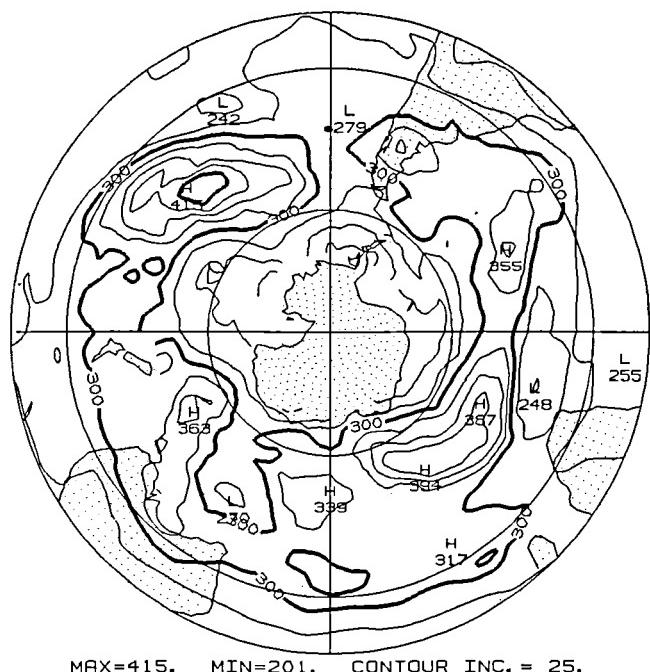


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TOMS TOTAL OZONE



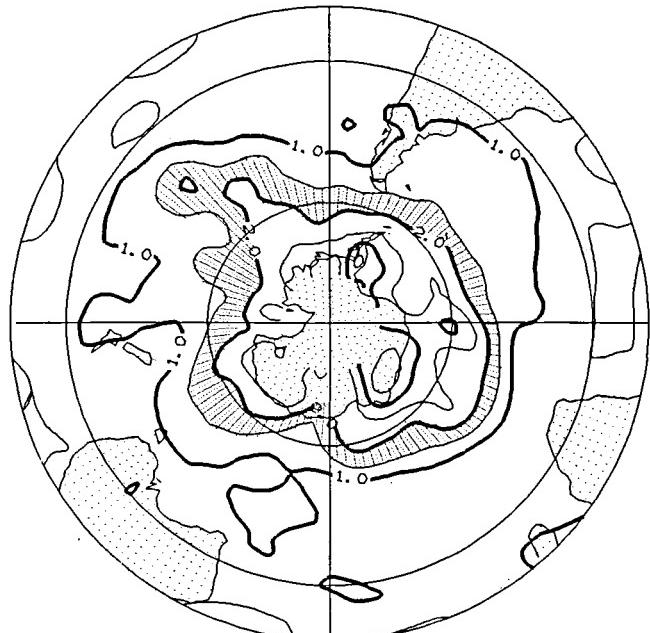
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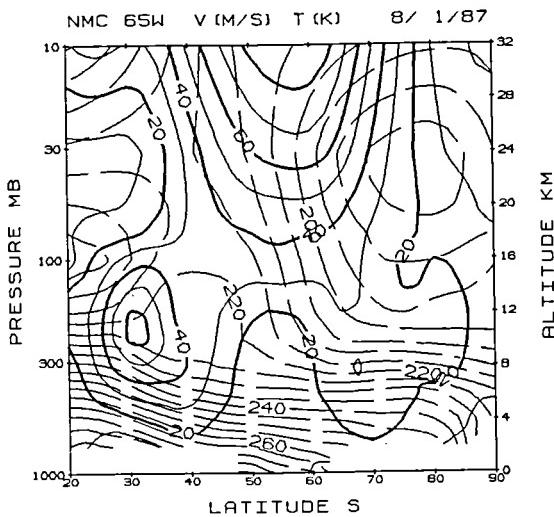
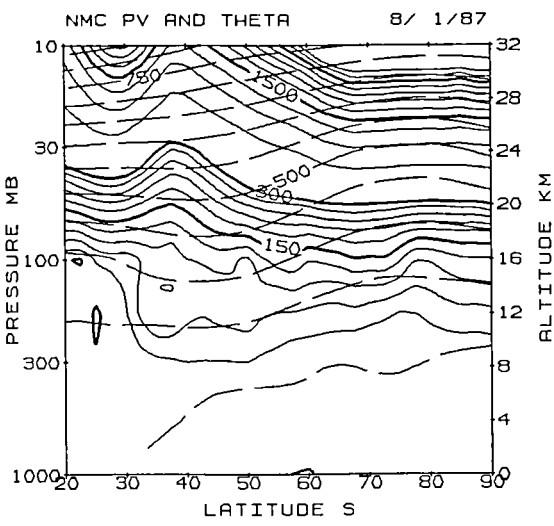
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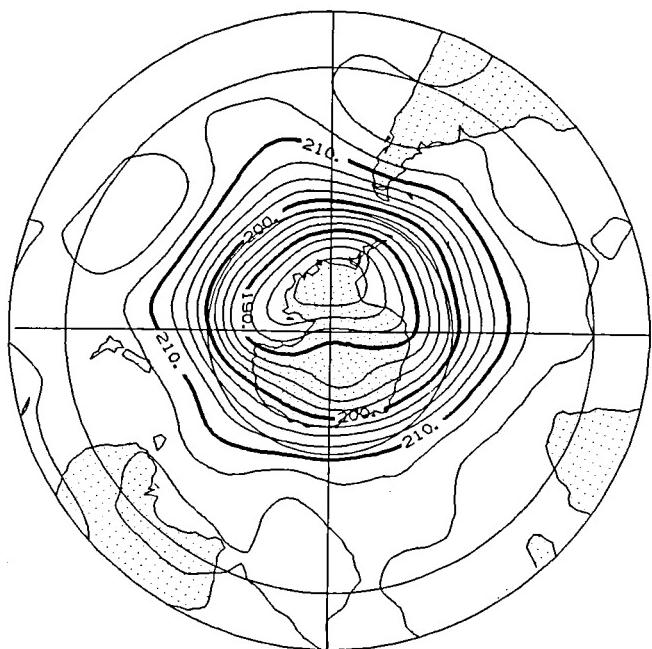
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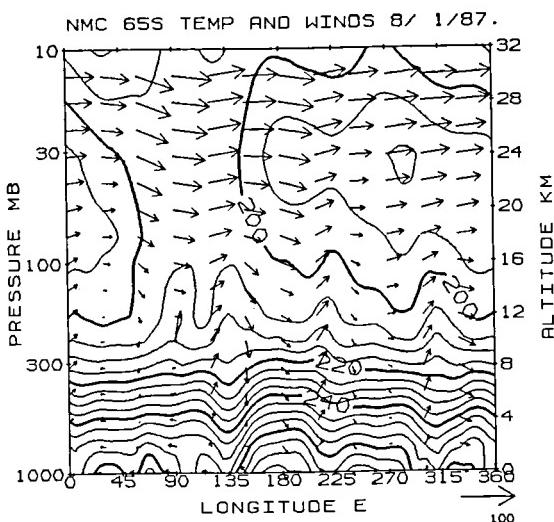




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NMC 200-100 THICK. T 0 8/ 2/87



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## TOMS TOTAL OZONE

8 / 2 / 87



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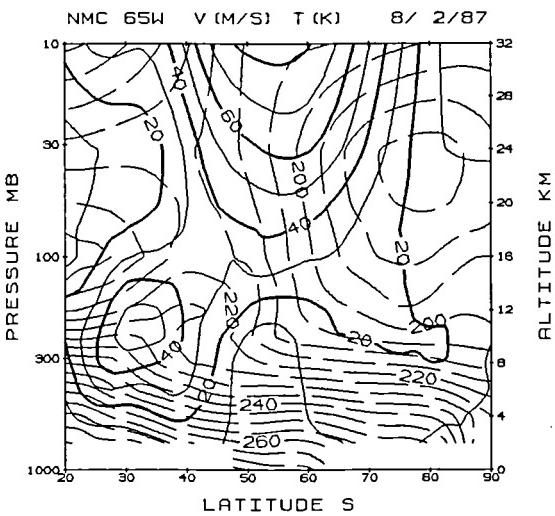
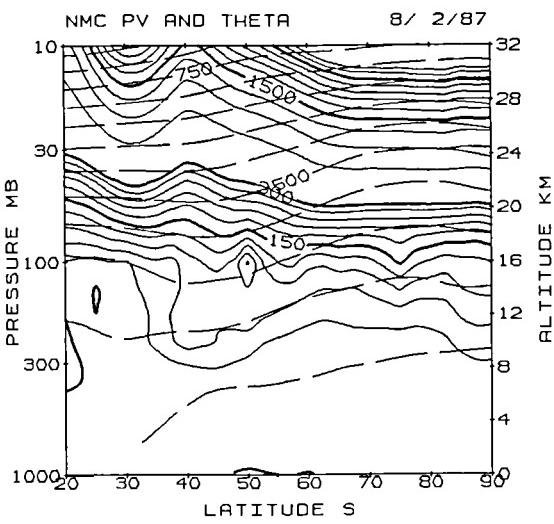
8/ 2/87



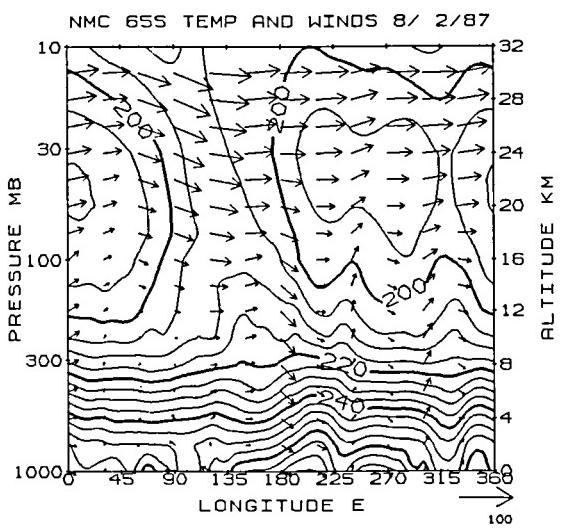
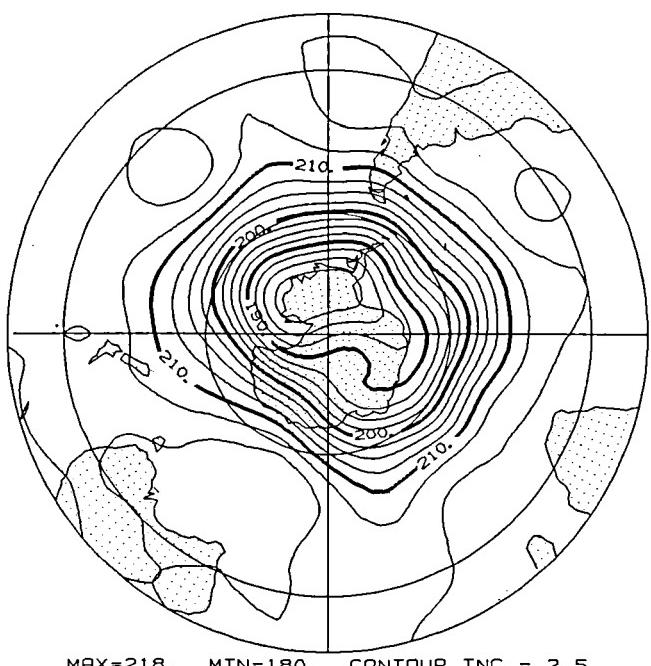
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NMC 50-30MB THICKNESS 8/ 2/87



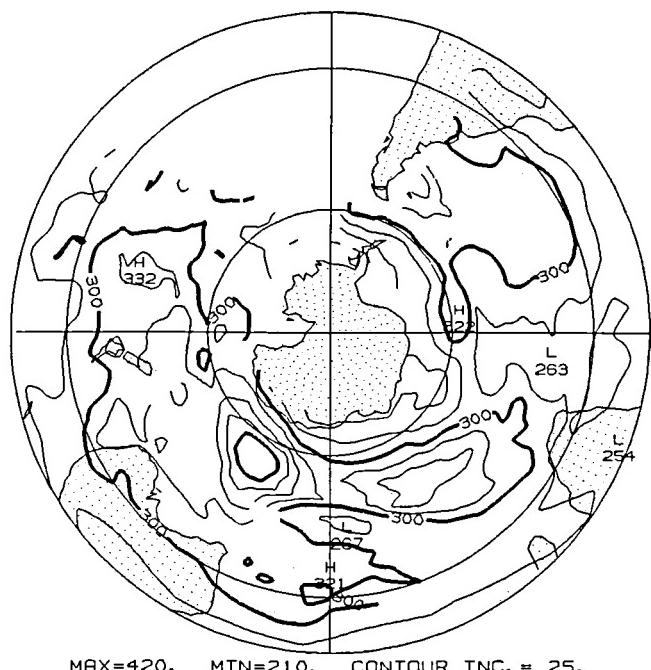
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TOMS TOTAL OZONE

8/ 3/87



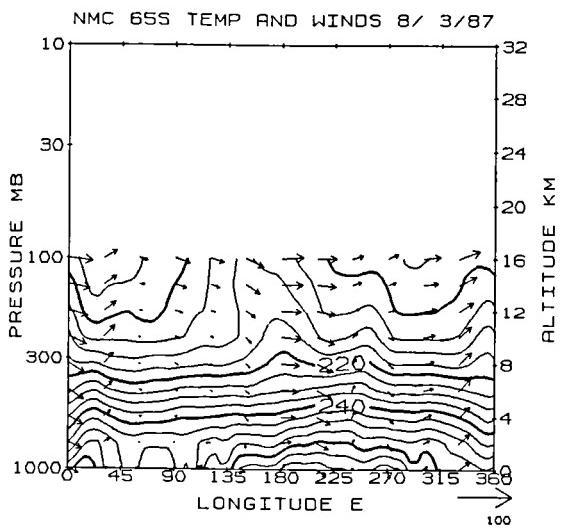
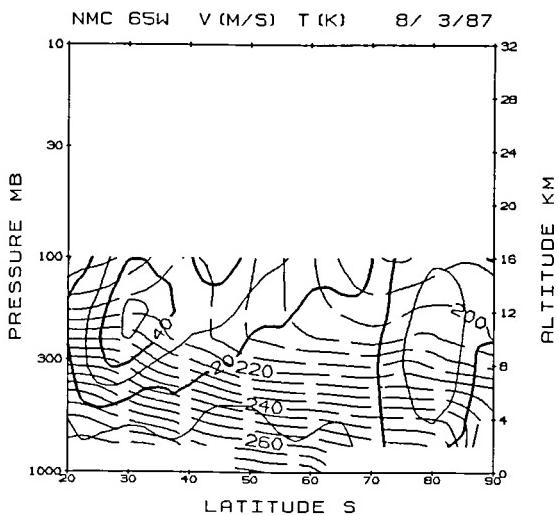
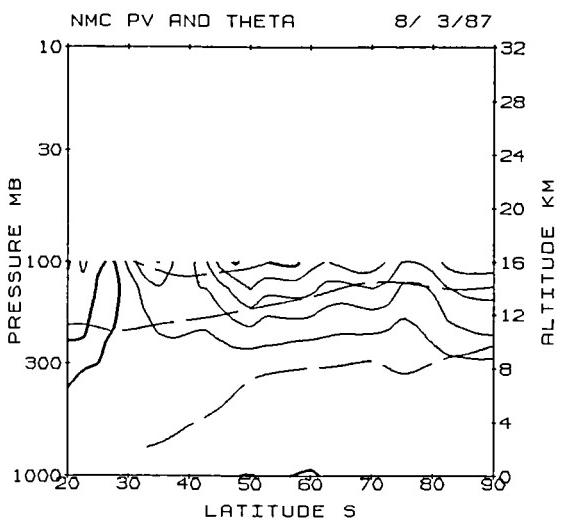
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TOMS TOTAL OZONE

8/ 4/87



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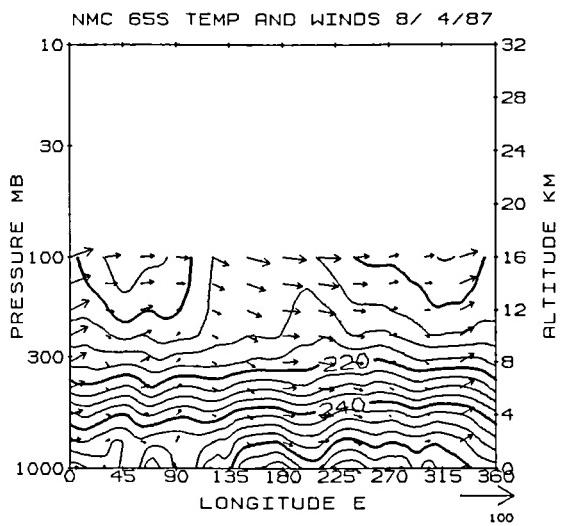
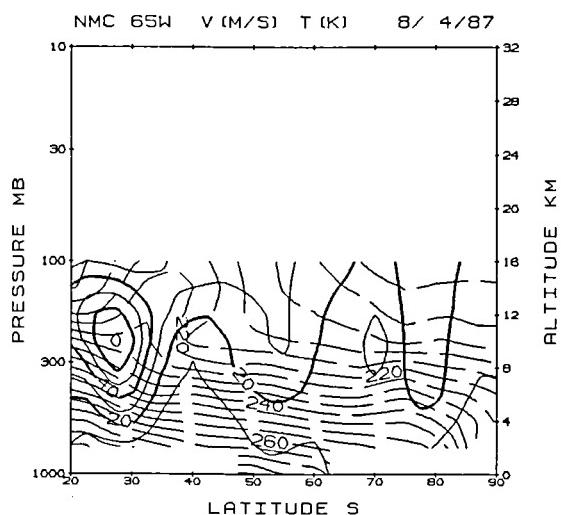
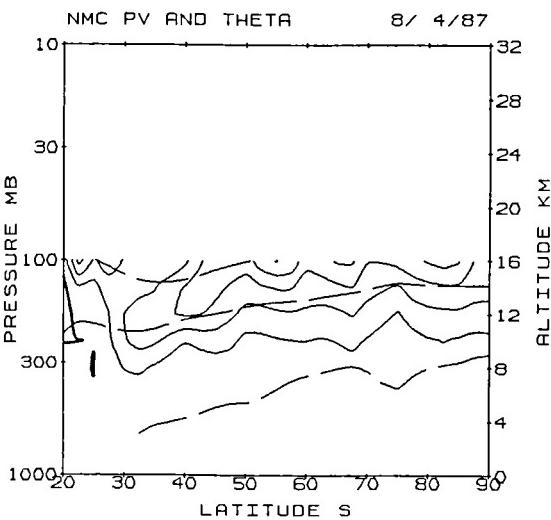


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TOMS TOTAL OZONE

8/ 5/87



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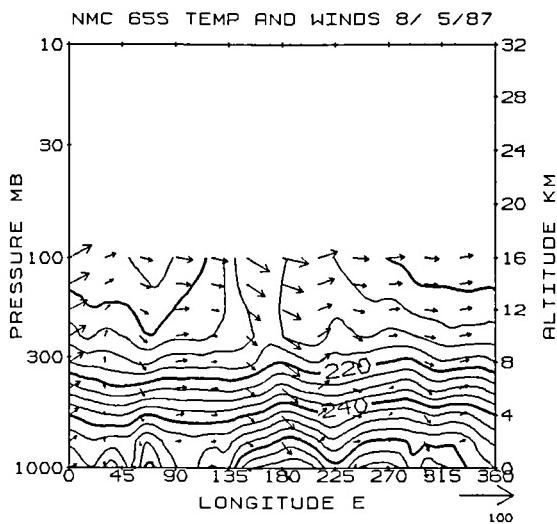
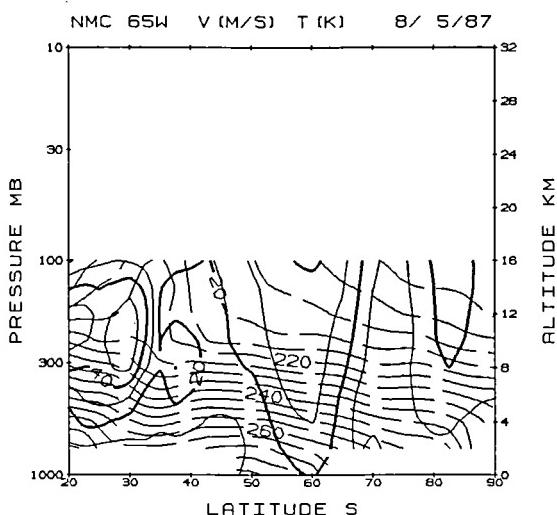
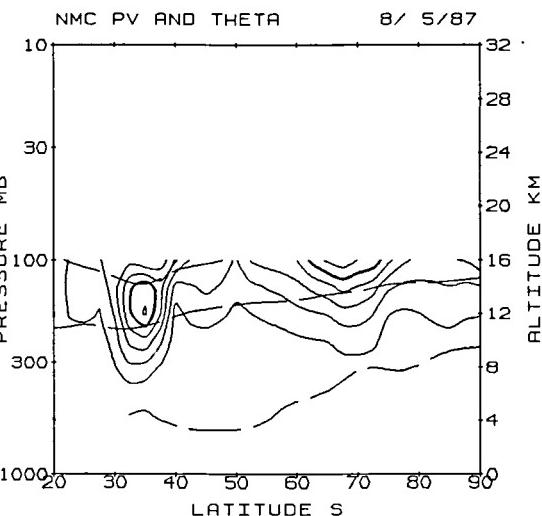


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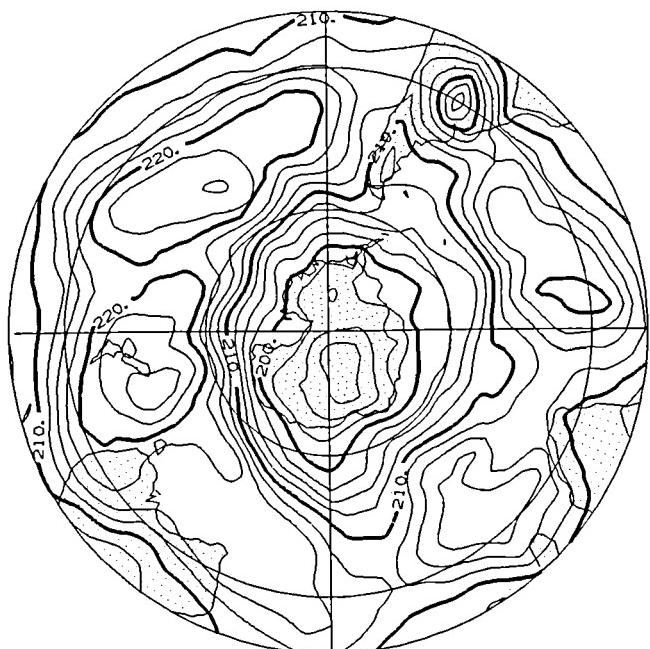
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TOMS TOTAL OZONE

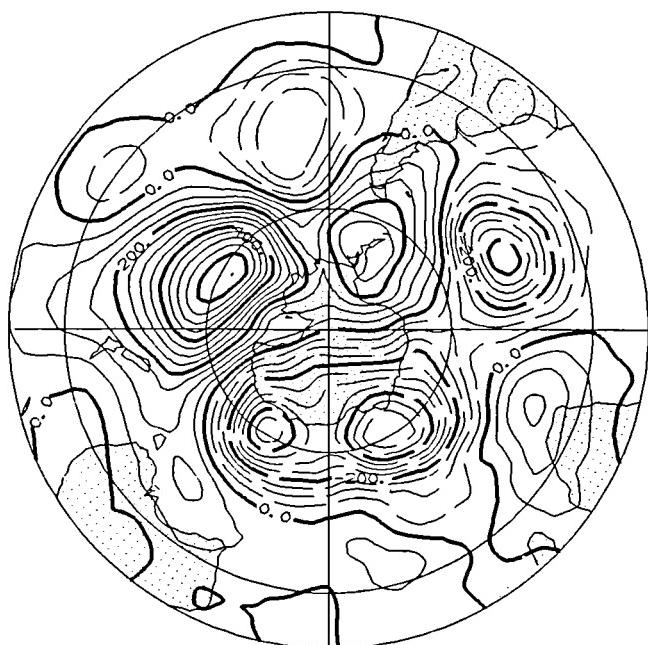
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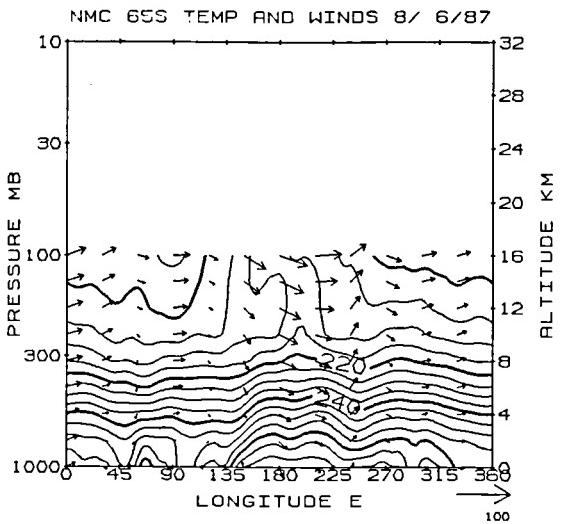
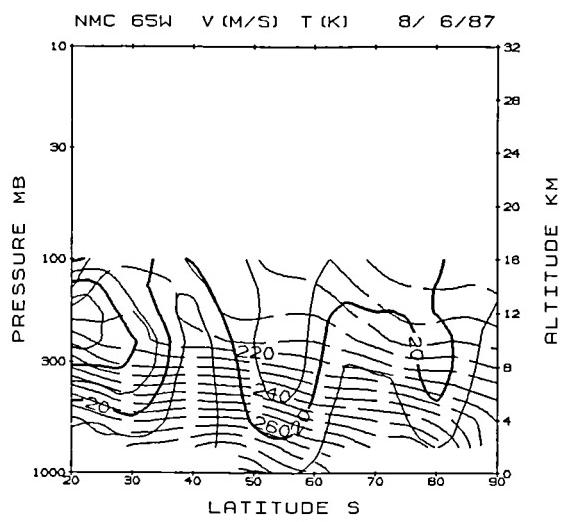
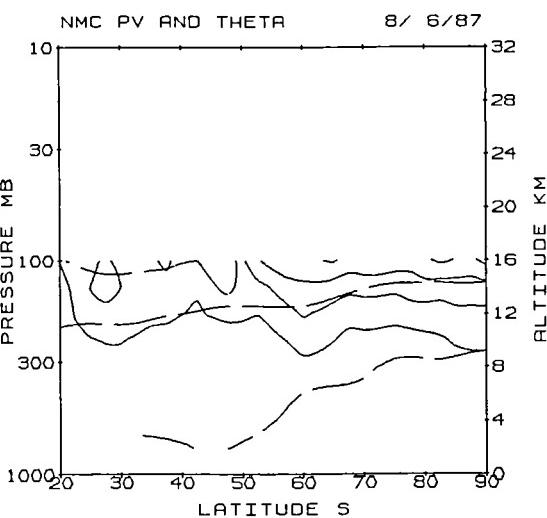
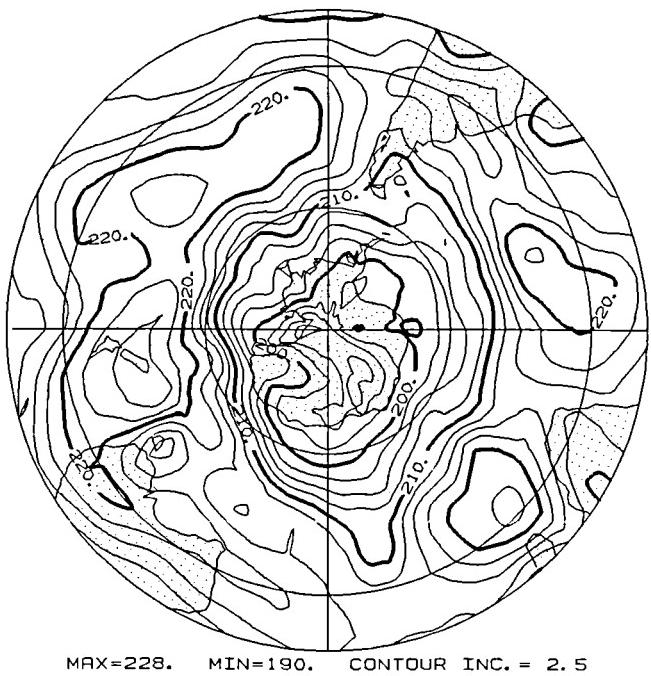
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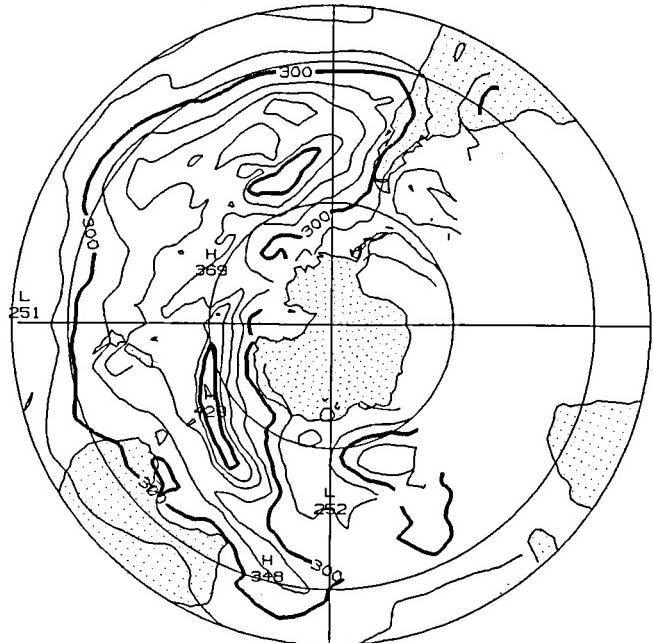


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## TOMS TOTAL OZONE

8 / 7 / 87



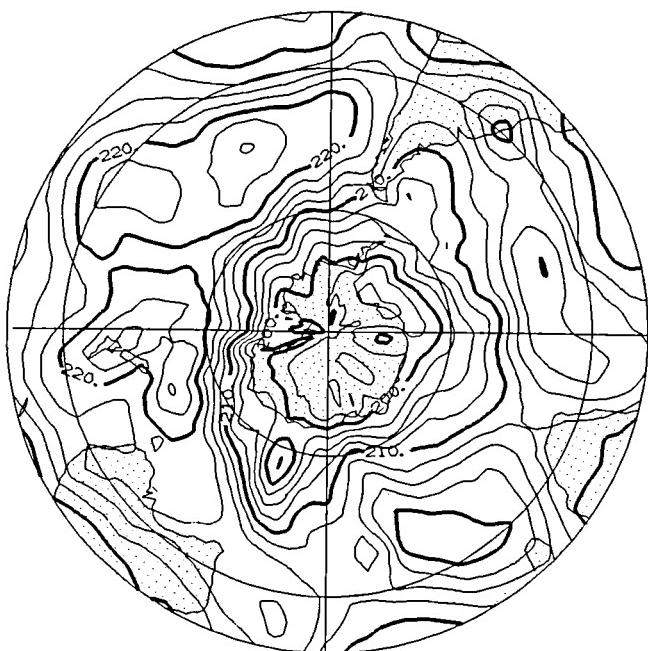
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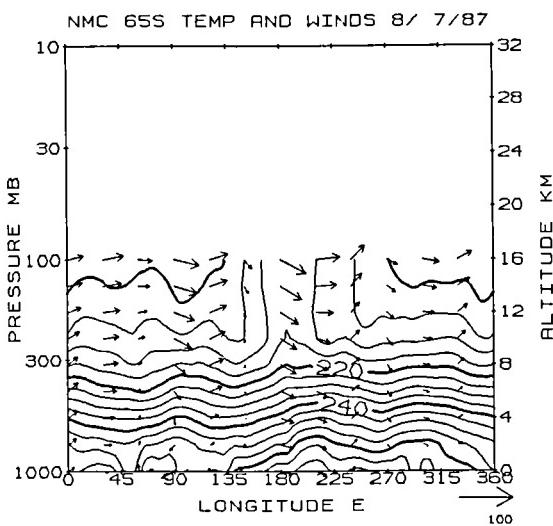
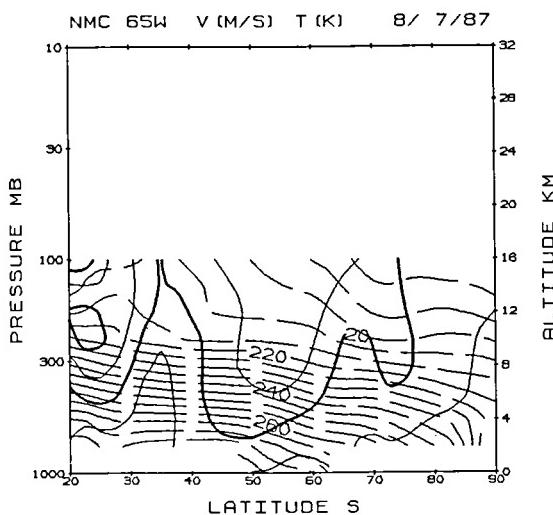
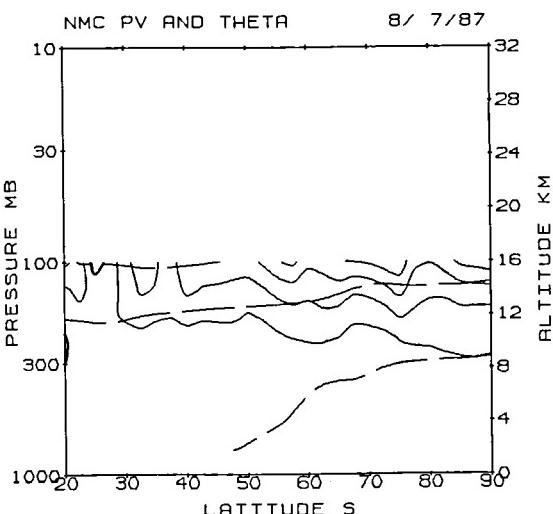


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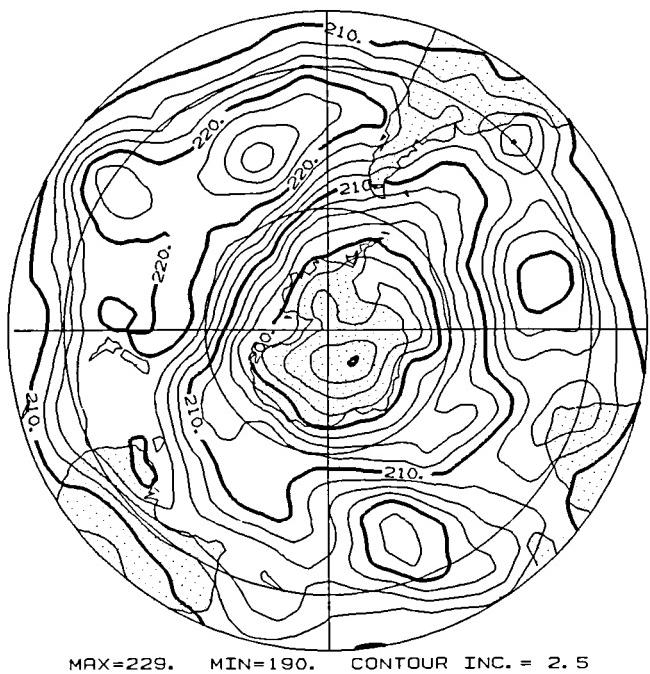
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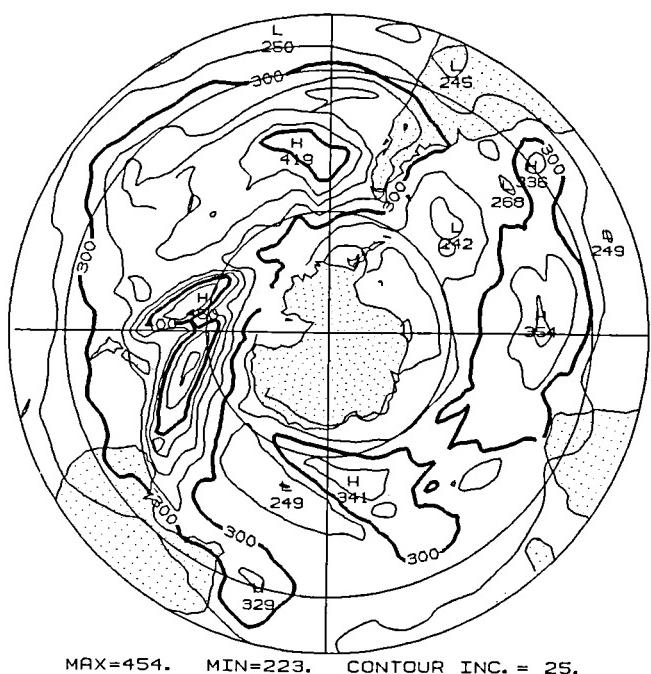


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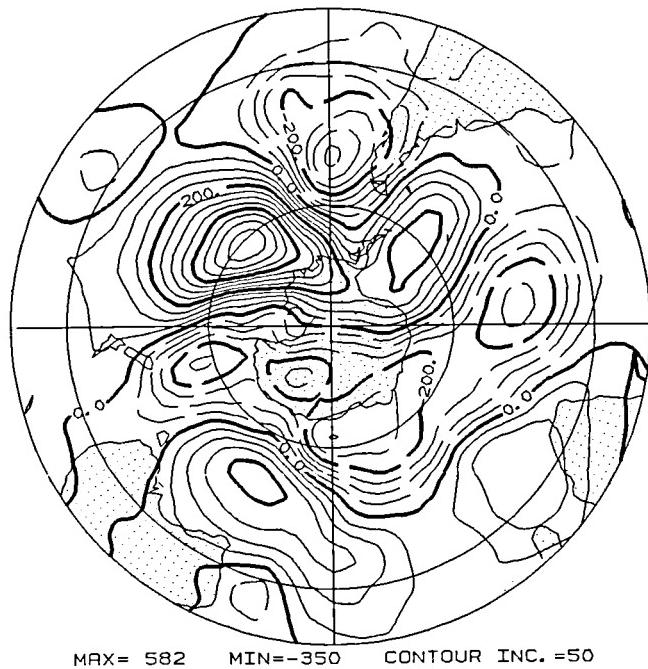


TOMS TOTAL OZONE

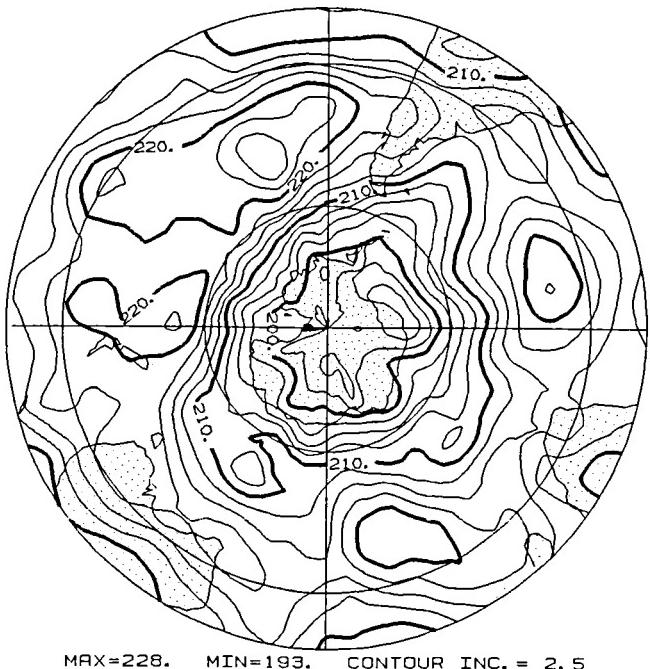
8/ 8/87



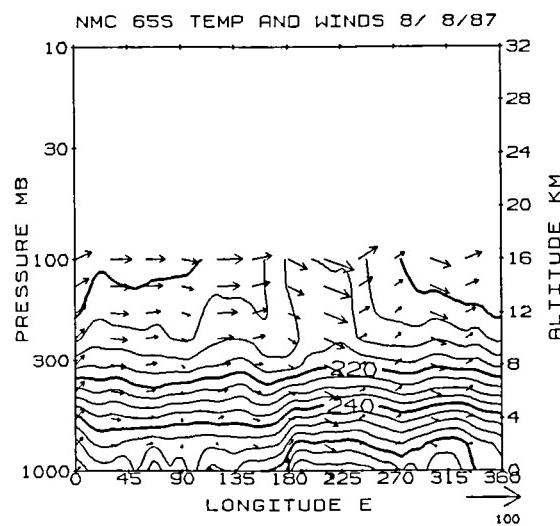
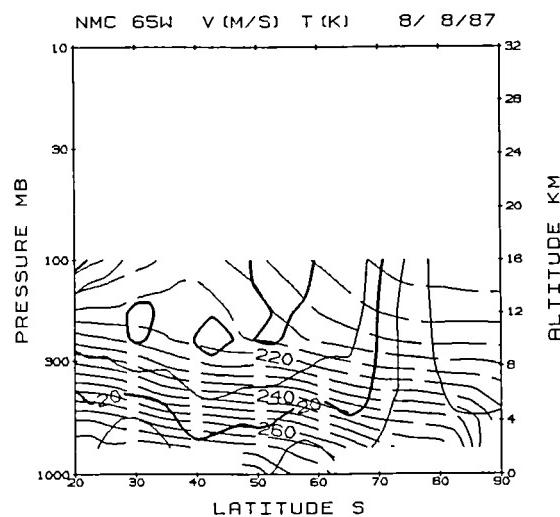
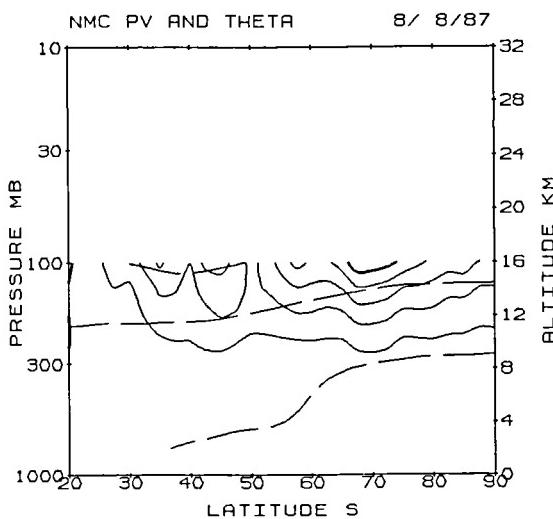
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GLA 200-100 THICK. T O 8/ 8/87



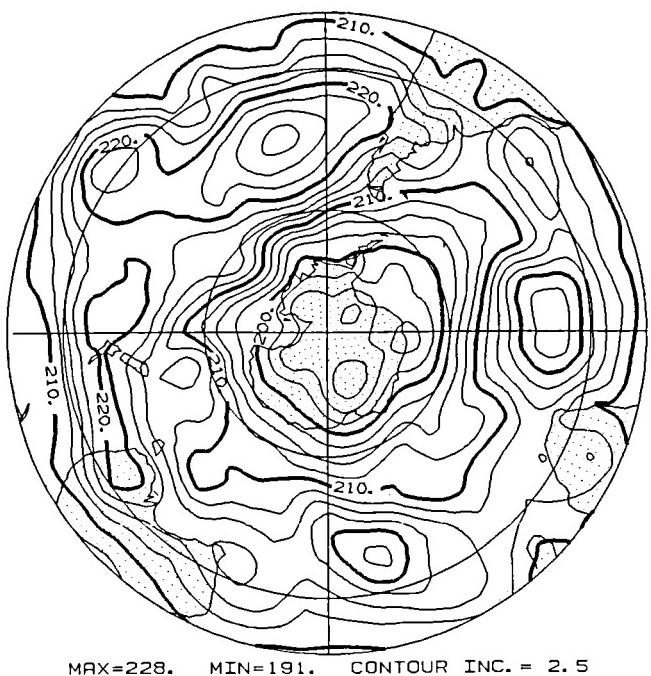
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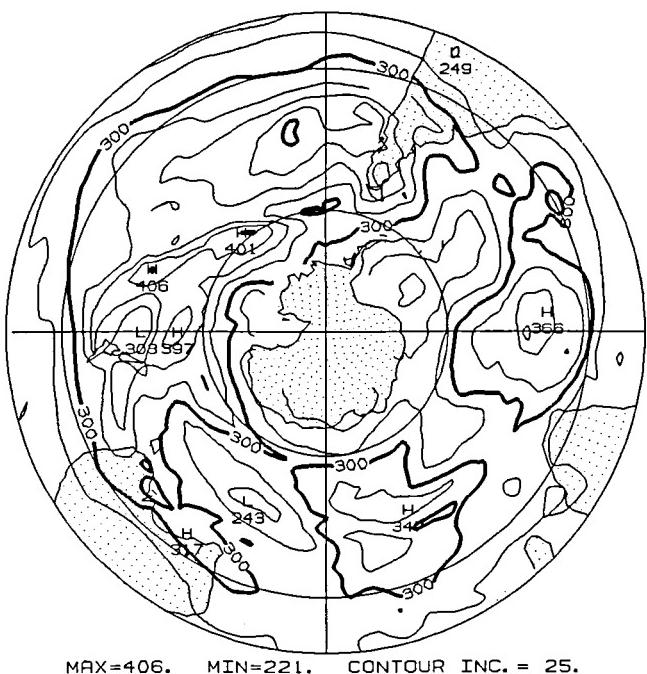
NMC 200-100 THICK. T 0 8/ 9/87

TOMS TOTAL OZONE

8/ 9/87

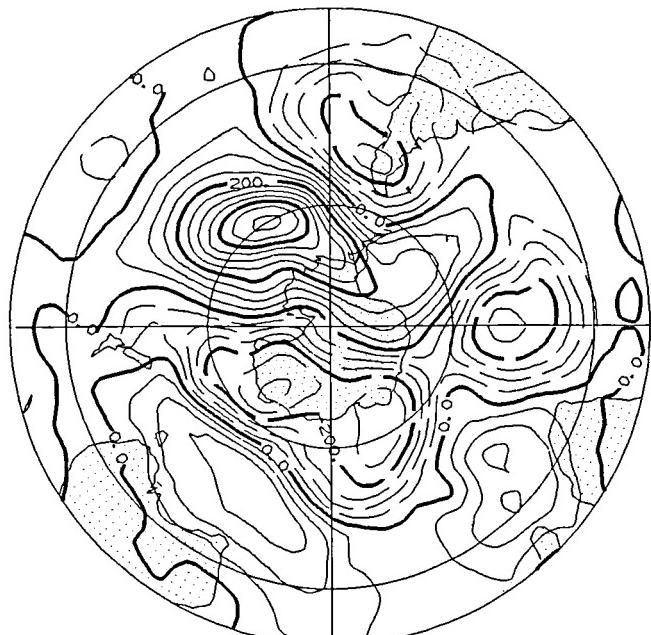


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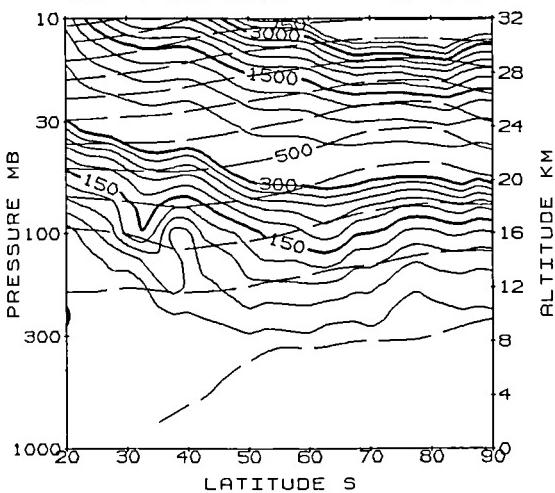
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NMC 50-30MB THICKNESS 8/ 9/87

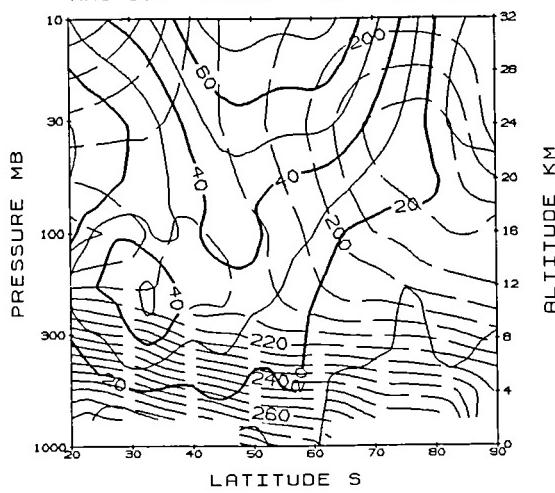


MAX=221. MIN=183. CONTOUR INC. = 2.5

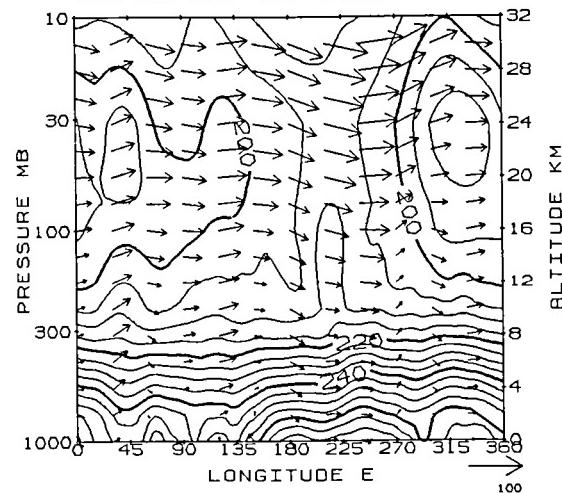
NMC PV AND THETA 8/ 9/87



NMC 65W V (M/S) T (K) 8/ 9/87



NMC 65S TEMP AND WINDS 8/ 9/87



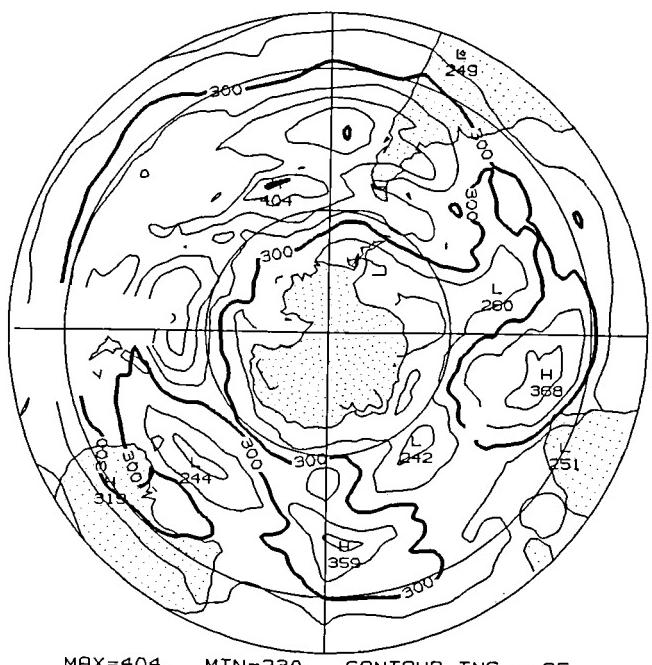
NMC 200-100 THICK. T O 8/10/87



MAX=229. MIN=191. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

8/10/87



MAX=404. MIN=230. CONTOUR INC. = 25.

NMC 100MB HGT DEV. 8/10/87

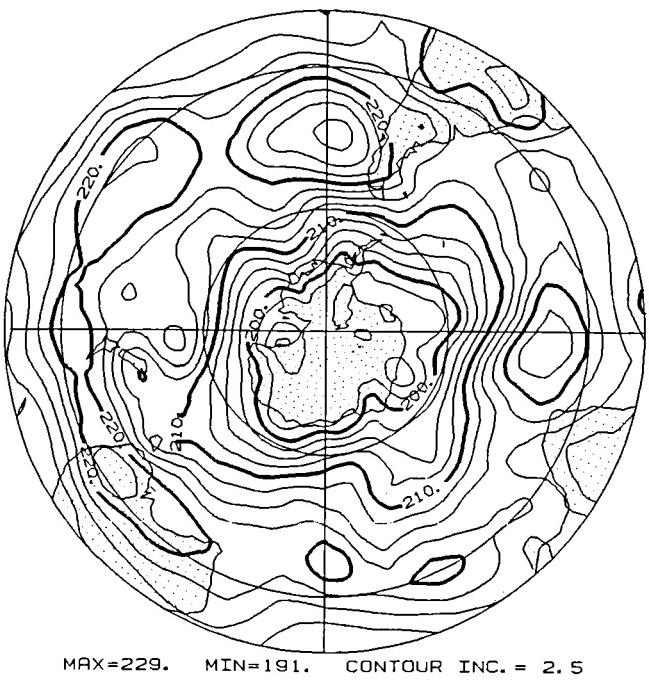


MAX= 450 MIN=-400 CONTOUR INC.=50

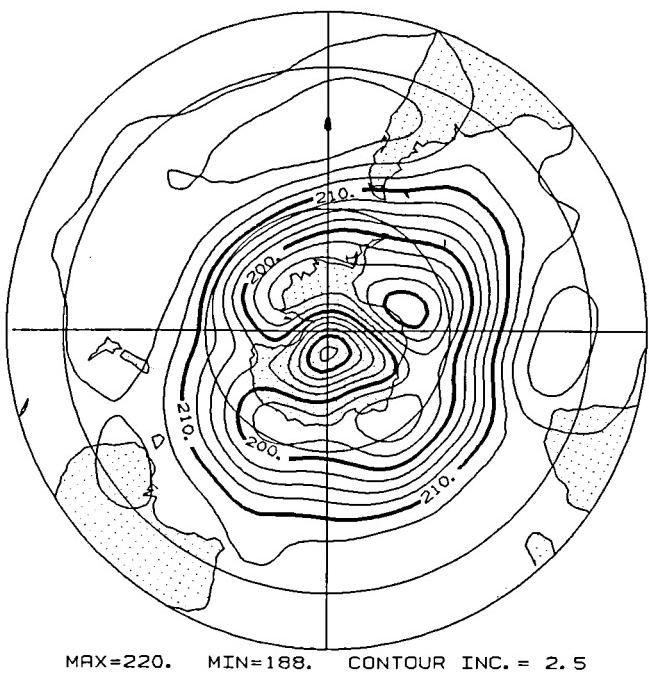
NMC 420K ERTEL POT VOR 8/10/87



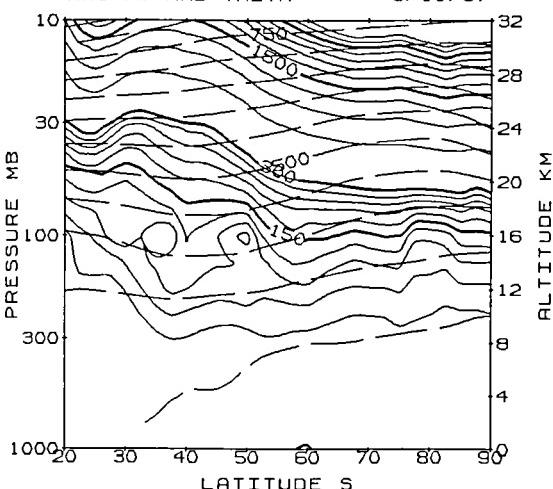
GLA 200-100 THICK. T 0 8/10/87



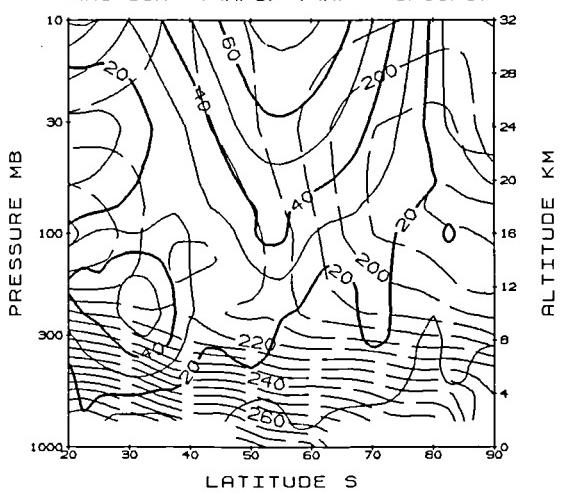
NMC 50-30MB THICKNESS 8/10/87



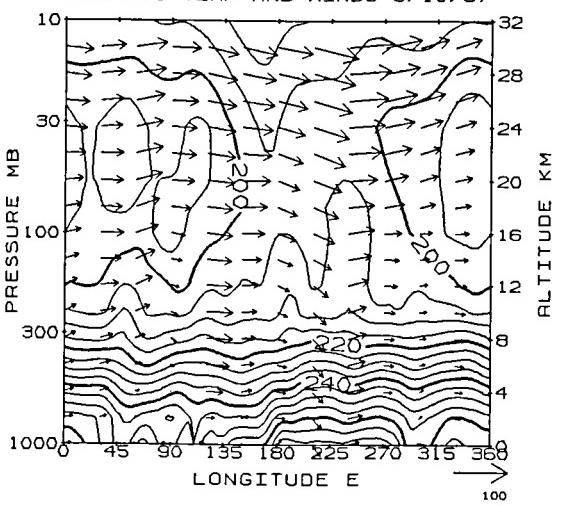
NMC PV AND THETA 8/10/87



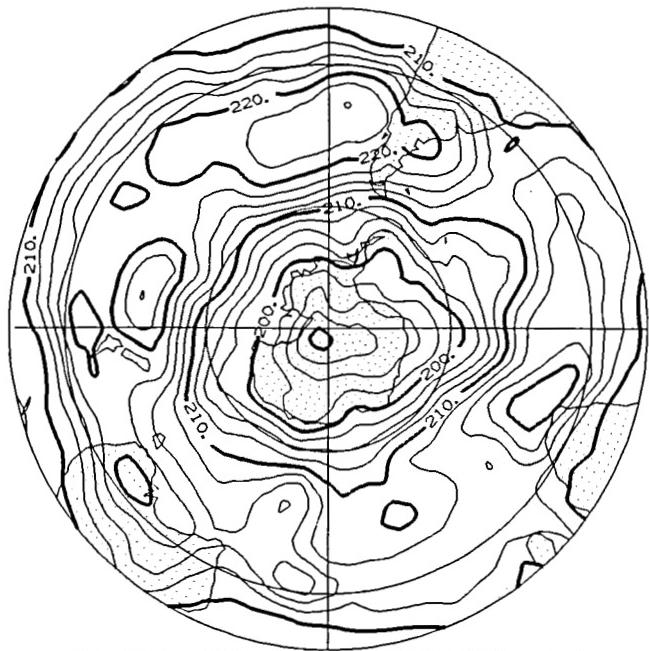
NMC 65W V (M/S) T (K) 8/10/87



NMC 65S TEMP AND WINDS 8/10/87



NMC 200-100 THICK. T O 8/11/87



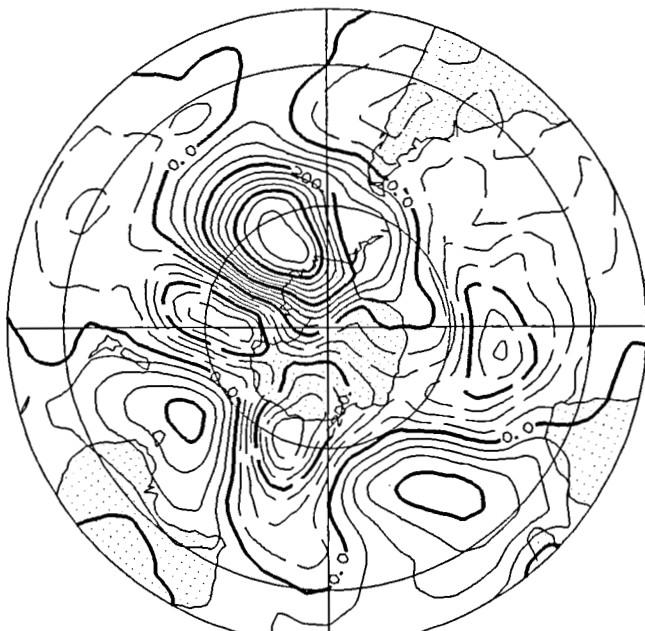
MAX=225. MIN=189. CONTOUR INC. = 2.5

TOMS TOTAL OZONE



MAX=434. MIN=225. CONTOUR INC. = 25.

NMC 100MB HGT DEV. 8/11/87

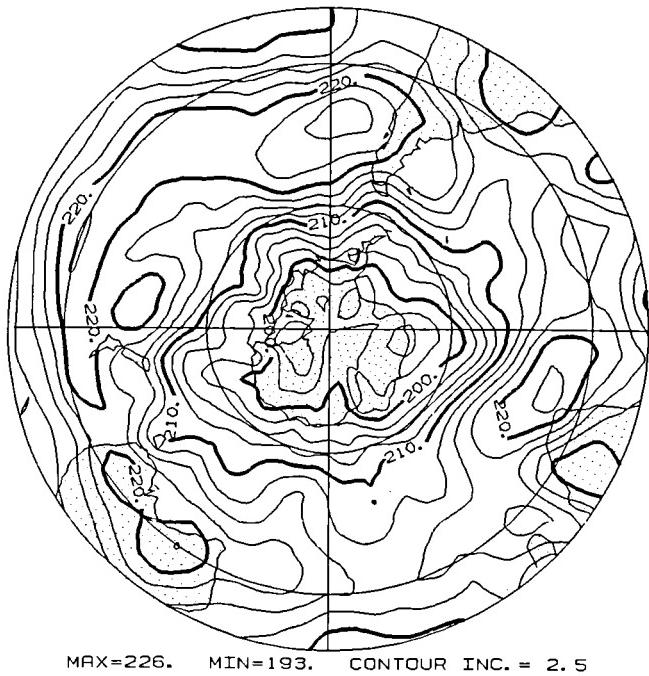


MAX= 536 MIN=-350 CONTOUR INC.=50

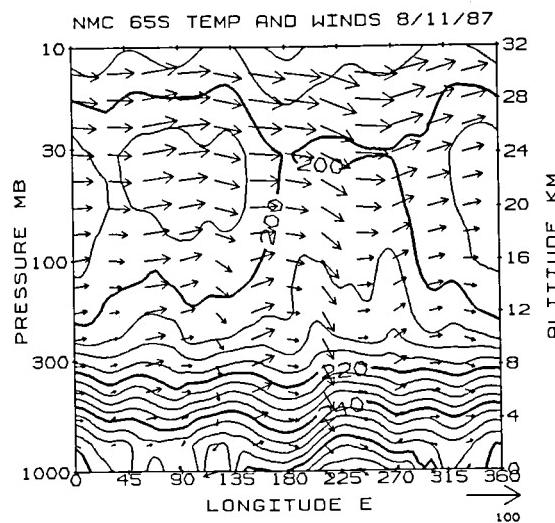
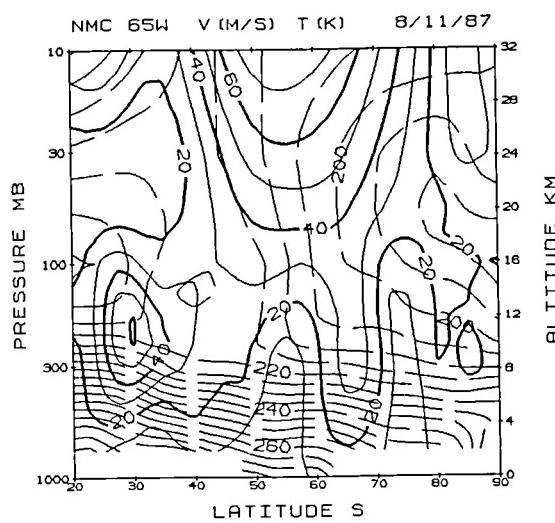
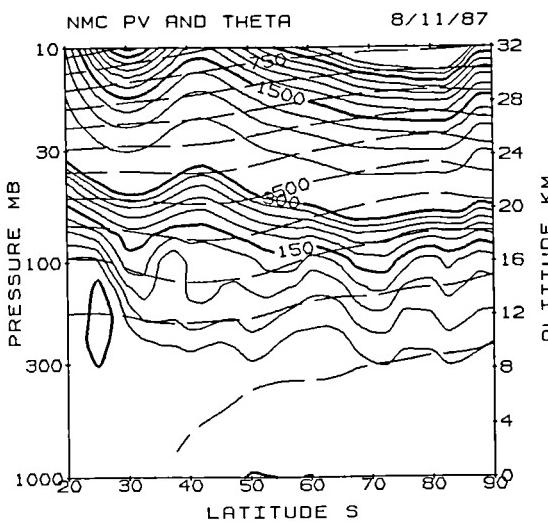
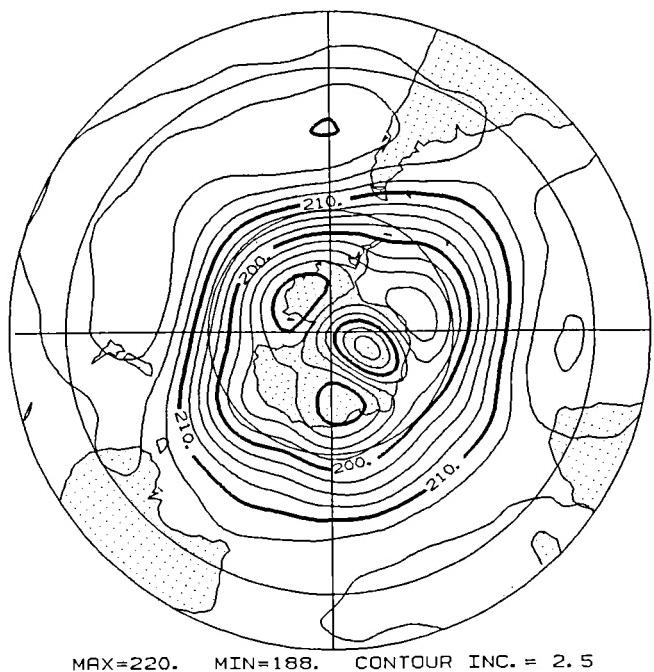
NMC 420K ERTEL POT VOR 8/11/87



GLA 200-100 THICK. T 0 8/11/87



NMC 50-30MB THICKNESS 8/11/87



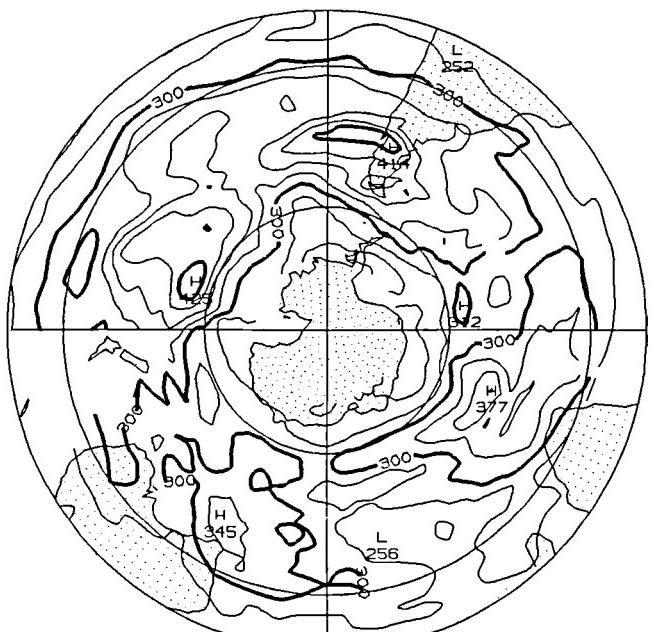
NMC 200-100 THICK. T 0 8/12/87



MAX=224. MIN=191. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

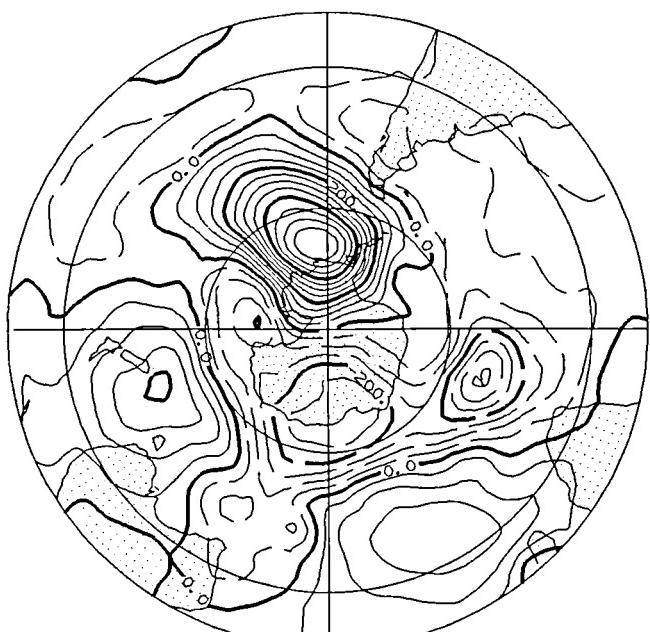
8/12/87



MAX=425. MIN=220. CONTOUR INC. = 25.

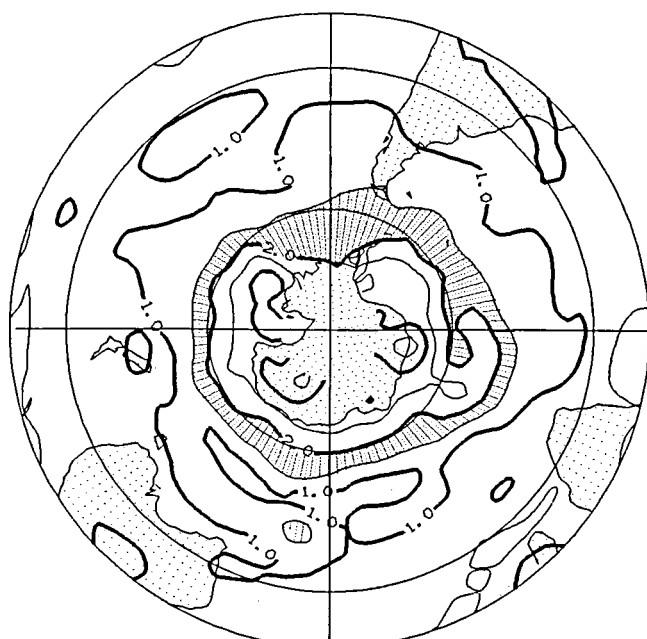
NMC 100MB HGT DEV.

8/12/87

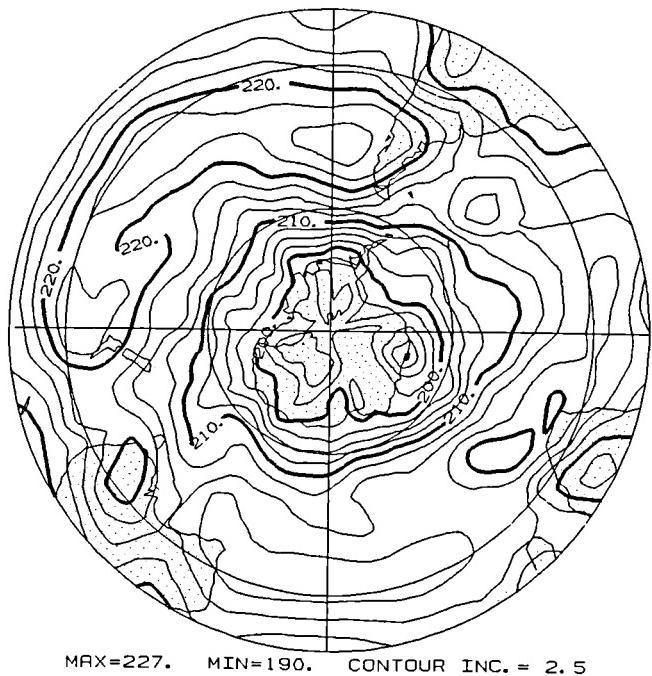


MAX= 600 MIN=-350 CONTOUR INC.=50

NMC 420K ERTEL POT VOR 8/12/87

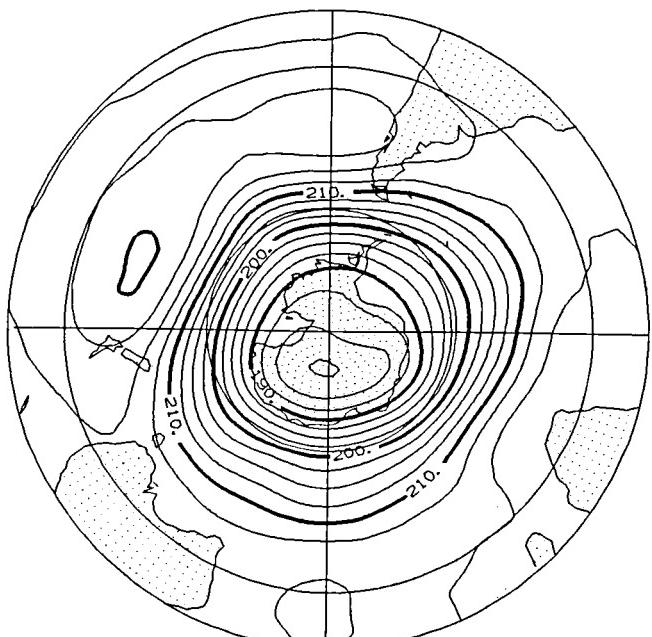


GLA 200-100 THICK. T O 8/12/87



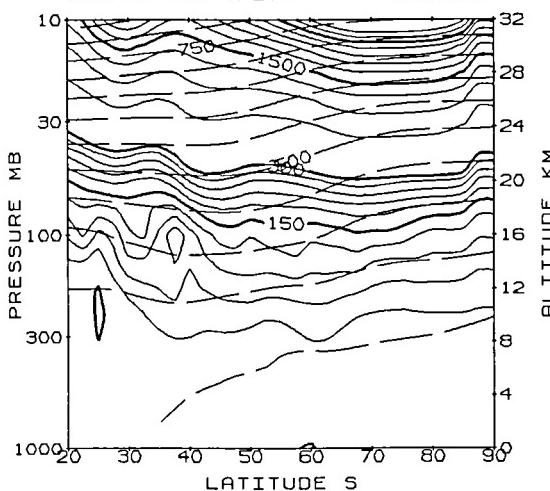
MAX=227. MIN=190. CONTOUR INC. = 2.5

NMC 50-30MB THICKNESS 8/12/87

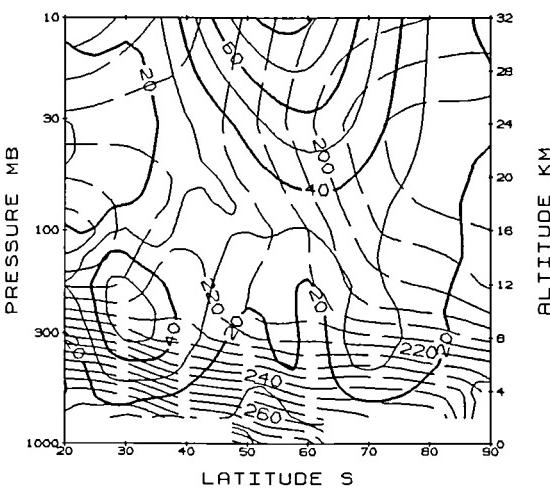


MAX=220. MIN=182. CONTOUR INC. = 2.5

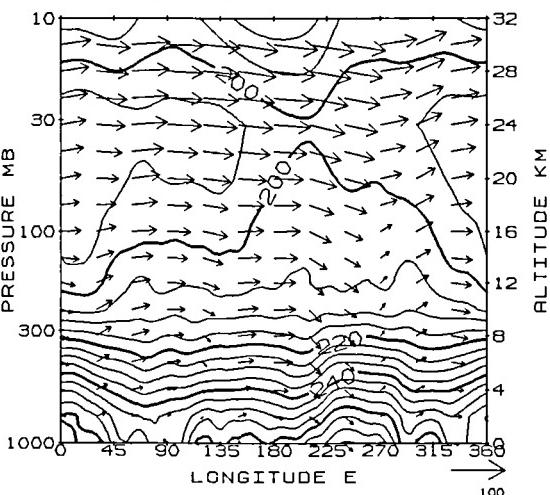
NMC PV AND THETA 8/12/87



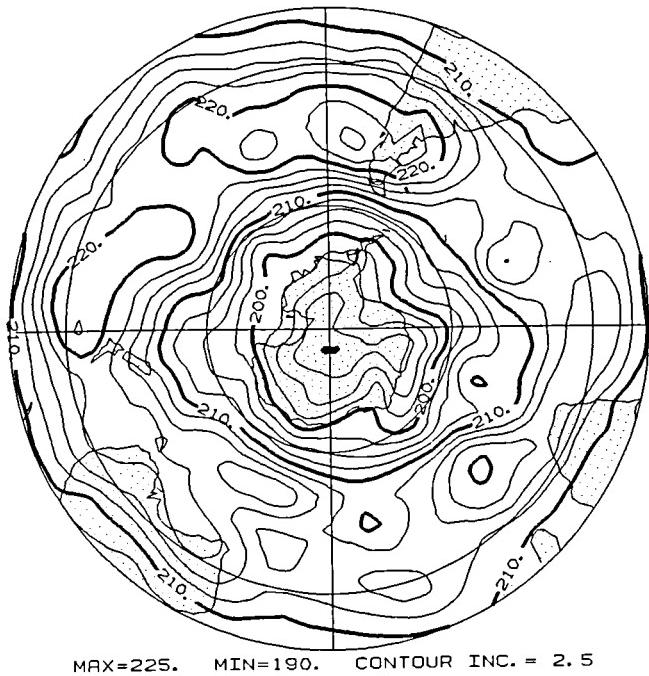
NMC 65W V (M/S) T (K) 8/12/87



NMC 65S TEMP AND WINDS 8/12/87

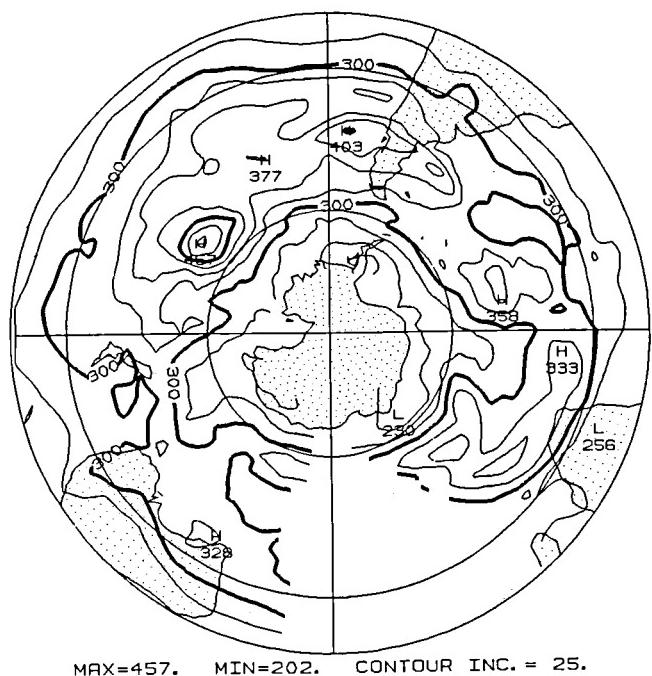


NMC 200-100 THICK. T O 8/13/87



TOMS TOTAL OZONE

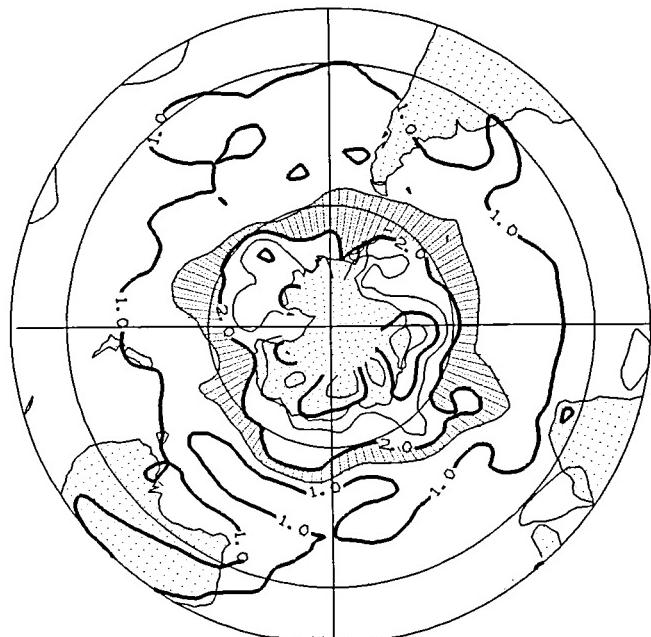
8/13/87



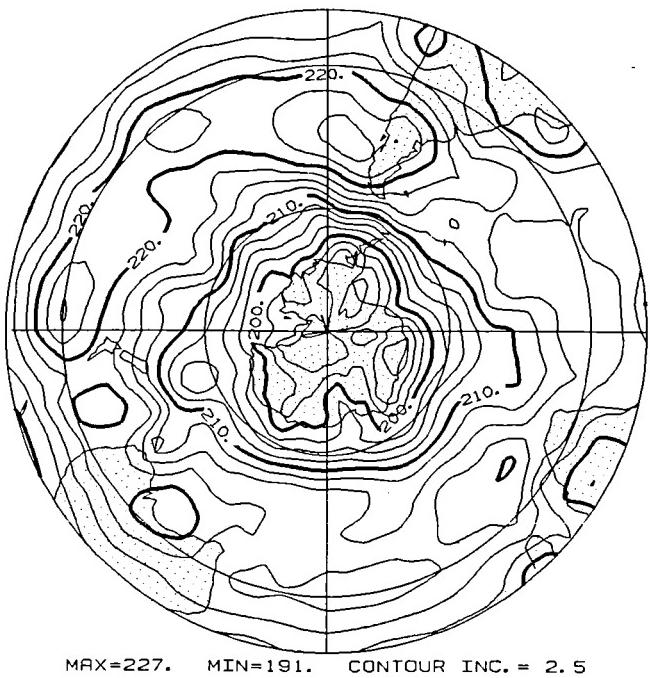
NMC 100MB HGT DEV. 8/13/87



NMC 420K ERTEL POT VOR 8/13/87

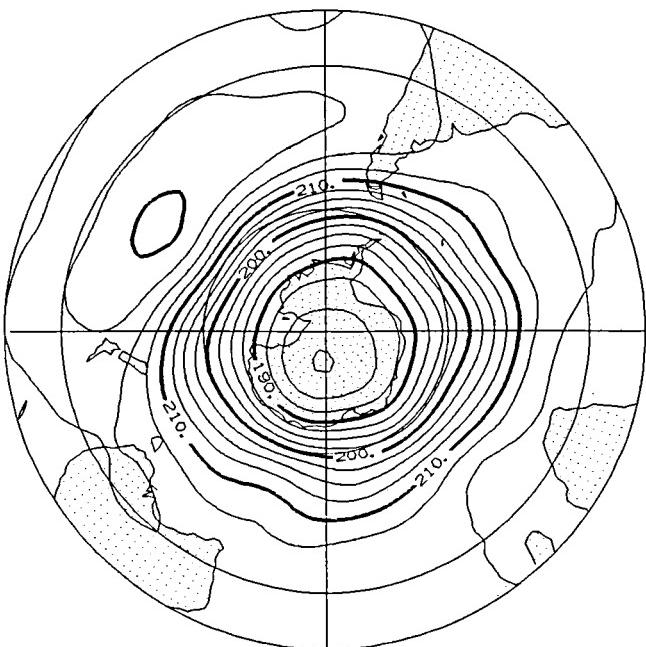


GLA 200-100 THICK. T 0 8/13/87



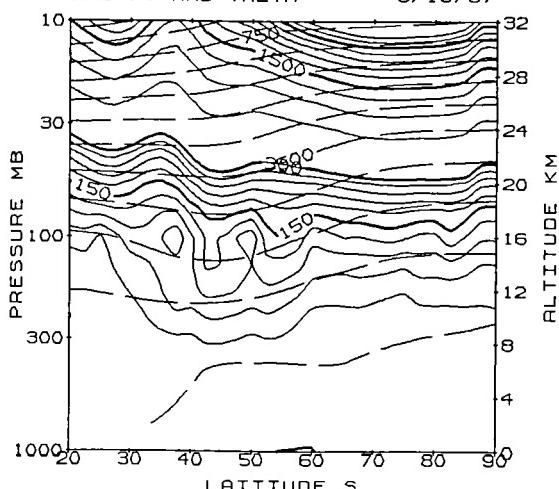
MAX=227. MIN=191. CONTOUR INC. = 2.5

NMC 50-30MB THICKNESS 8/13/87

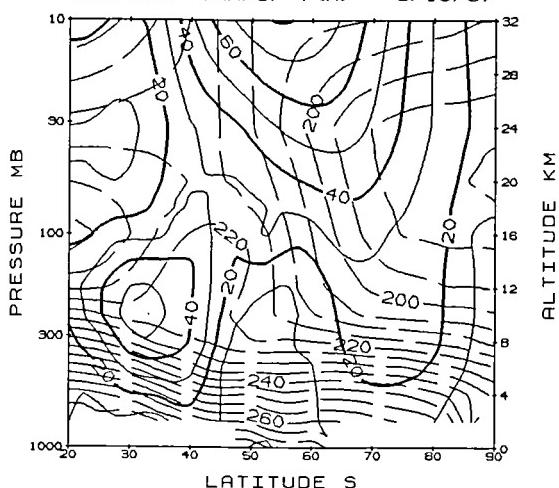


MAX=221. MIN=182. CONTOUR INC. = 2.5

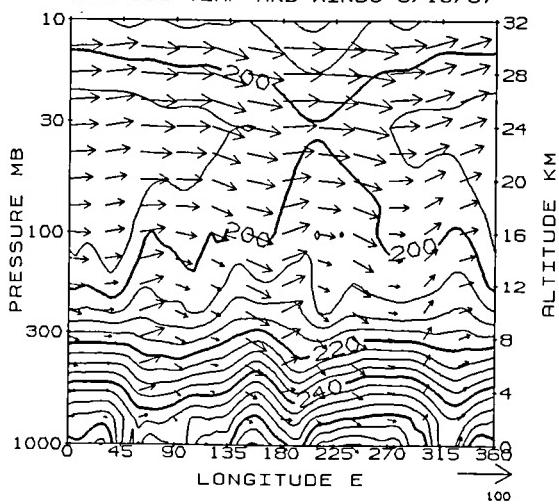
NMC PV AND THETA 8/13/87



NMC 65W V (M/S) T (K) 8/13/87



NMC 65S TEMP AND WINDS 8/13/87

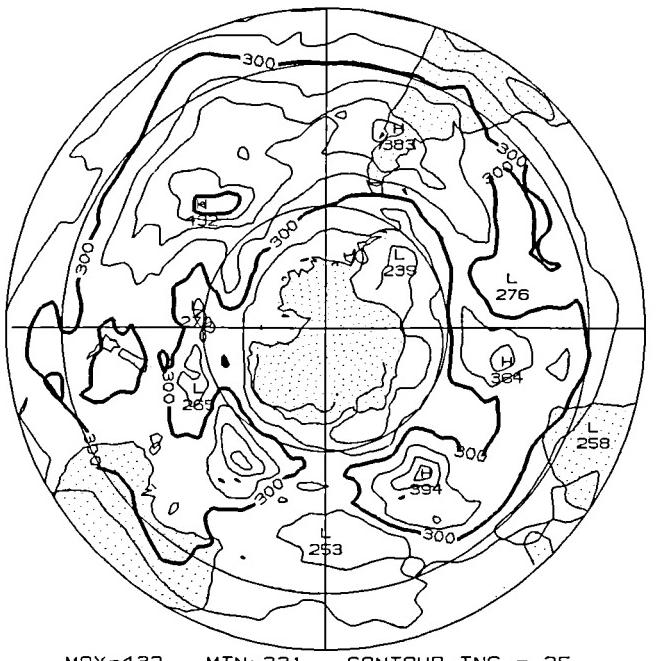


NMC 200-100 THICK. T O 8/14/87



MAX=226. MIN=190. CONTOUR INC. = 2.5

TOMS TOTAL OZONE



MAX=432. MIN=231. CONTOUR INC. = 25.

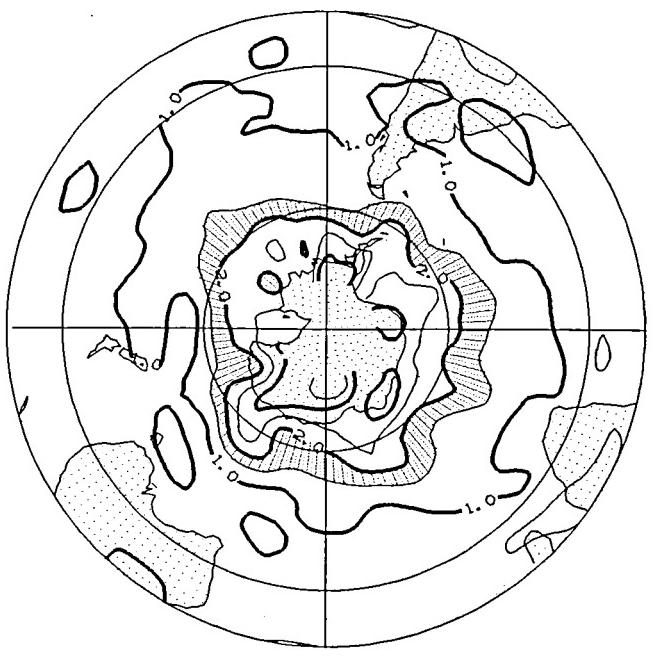
NMC 100MB HGT DEV.

8/14/87



MAX= 454 MIN=-350 CONTOUR INC.=50

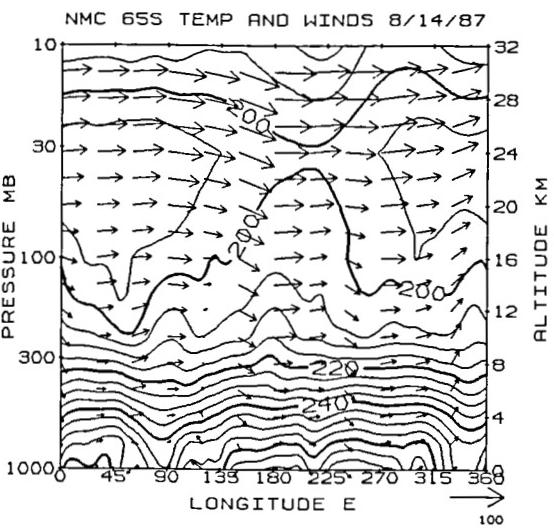
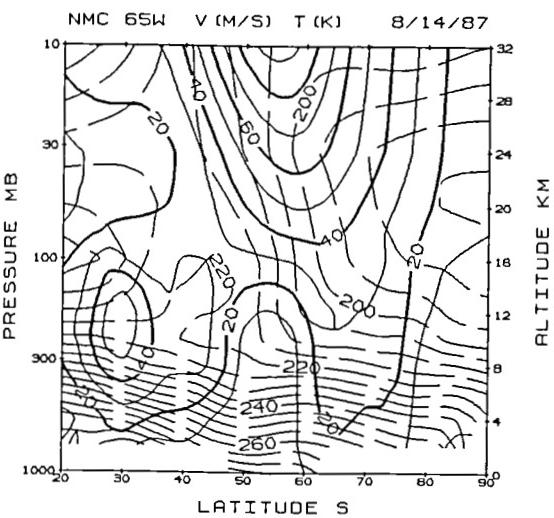
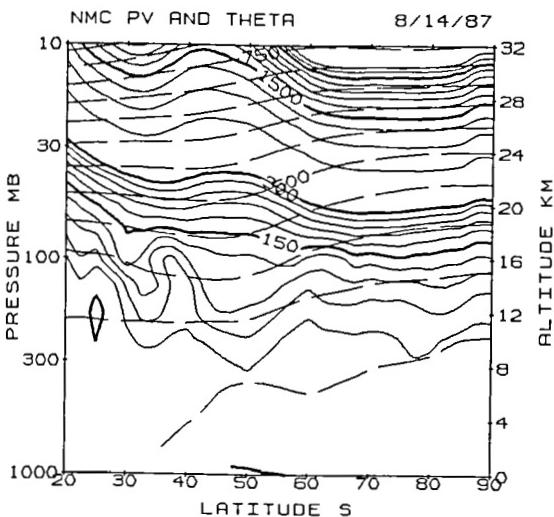
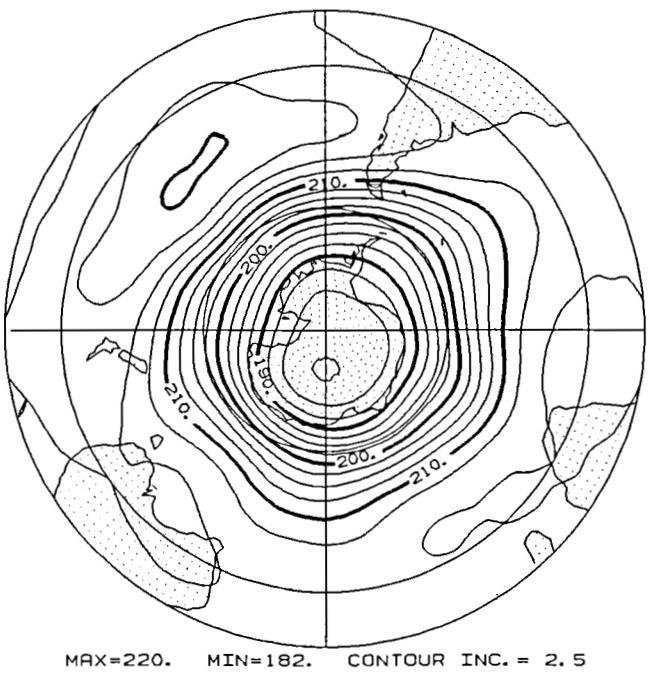
NMC 420K ERTEL POT VOR 8/14/87



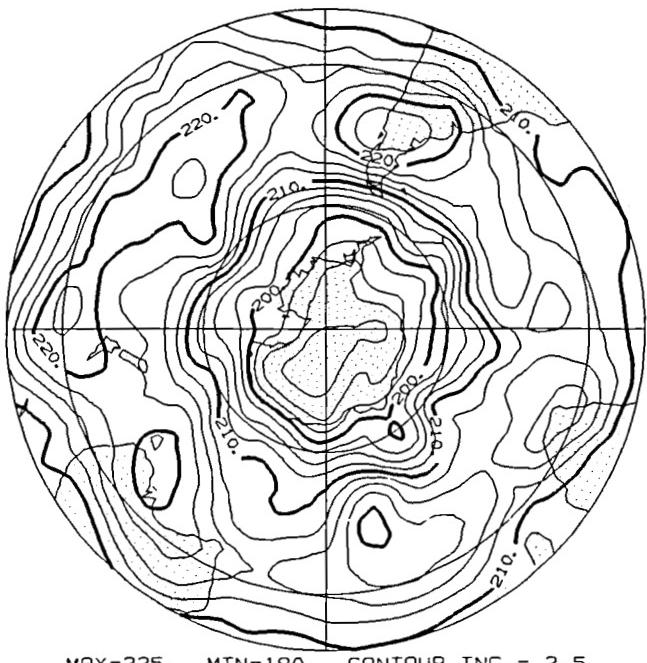
GLA 200-100 THICK. T O 8/14/87



NMC 50-30MB THICKNESS 8/14/87



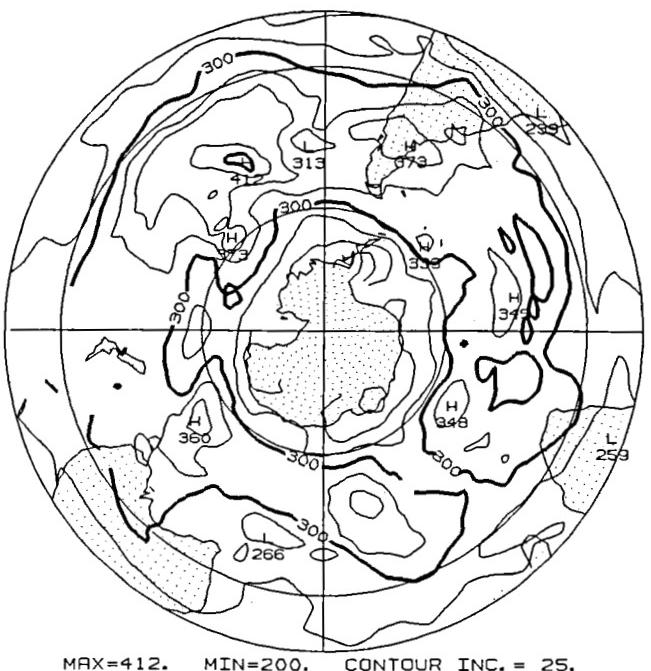
NMC 200-100 THICK. T O 8/15/87



MAX=225. MIN=190. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

8/15/87



MAX=412. MIN=200. CONTOUR INC. = 25.

NMC 100MB HGT DEV.

8/15/87

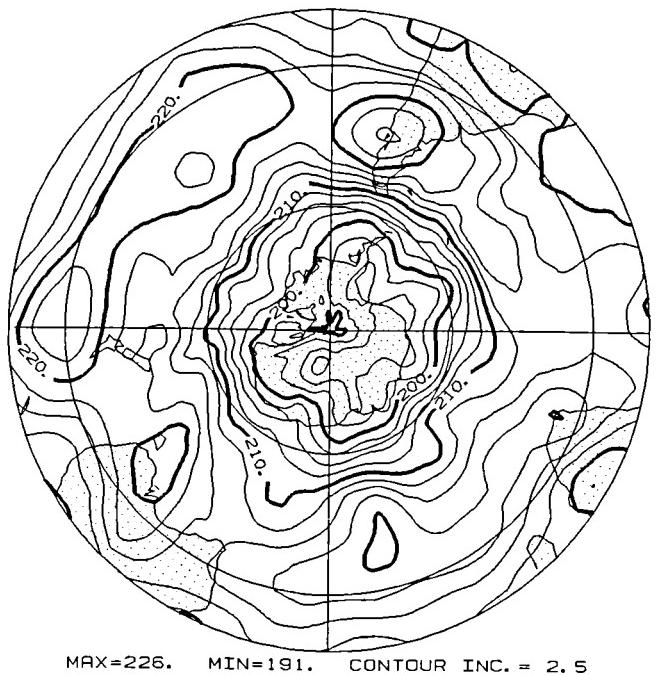


MAX= 452 MIN=-350 CONTOUR INC.=50

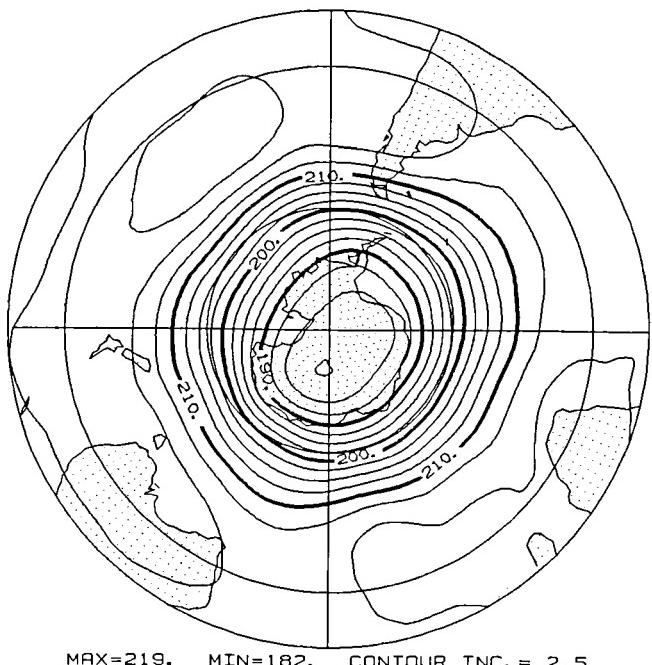
NMC 420K ERTEL POT VOR 8/15/87



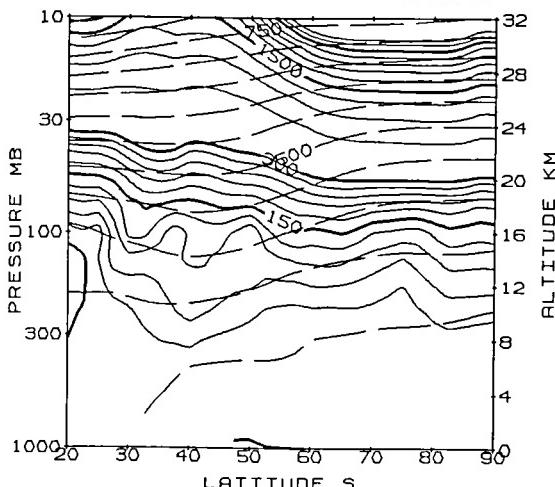
GLA 200-100 THICK. T 0 8/15/87



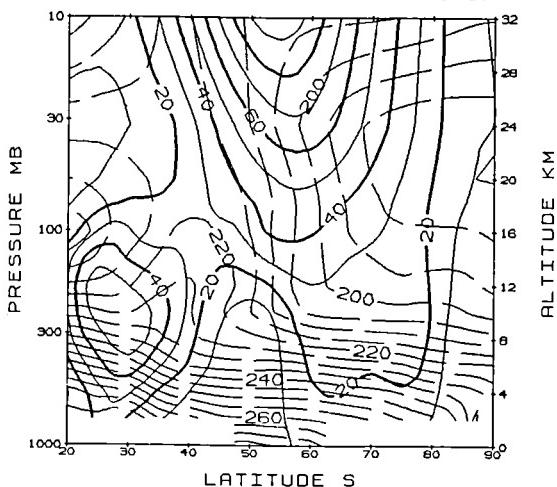
NMC 50-30MB THICKNESS 8/15/87



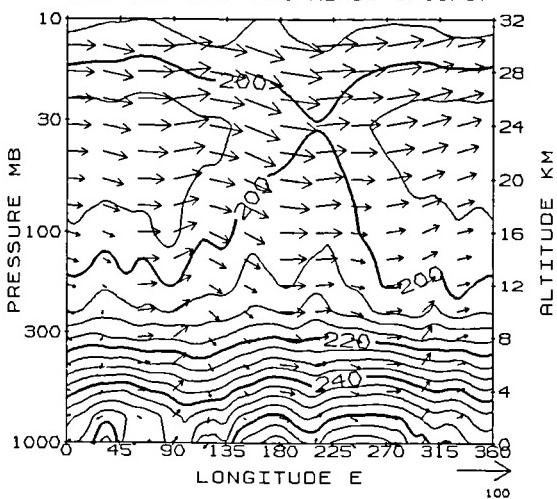
NMC PV AND THETA 8/15/87



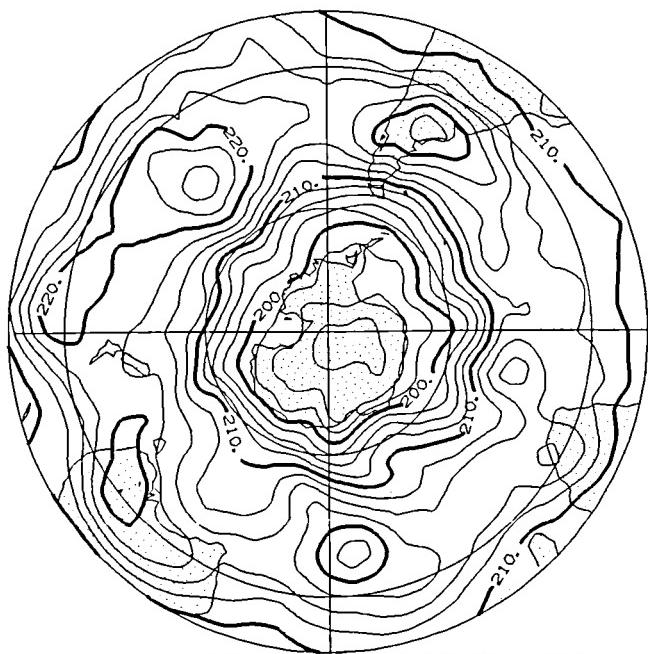
NMC 65W V (M/S) T (K) 8/15/87



NMC 65S TEMP AND WINDS 8/15/87



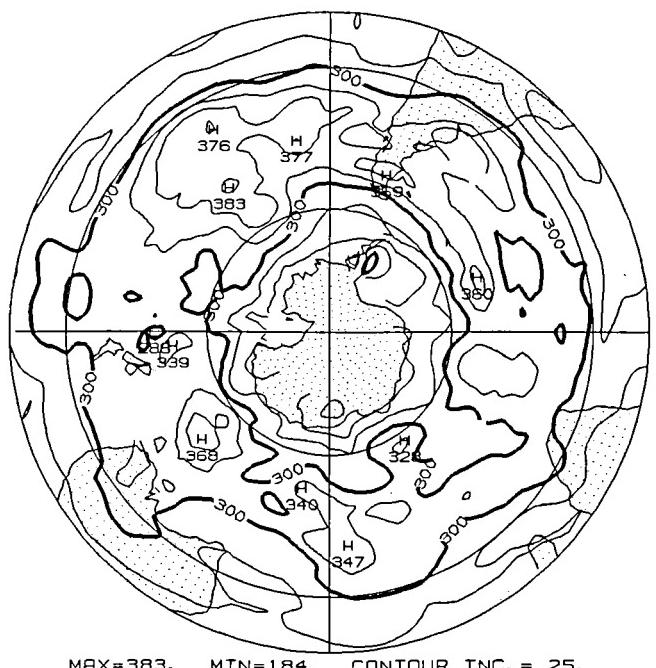
NMC 200-100 THICK. T 0 8/16/87



MAX=226. MIN=191. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

8/16/87



MAX=383. MIN=184. CONTOUR INC. = 25.

NMC 100MB HGT DEV.

8/16/87

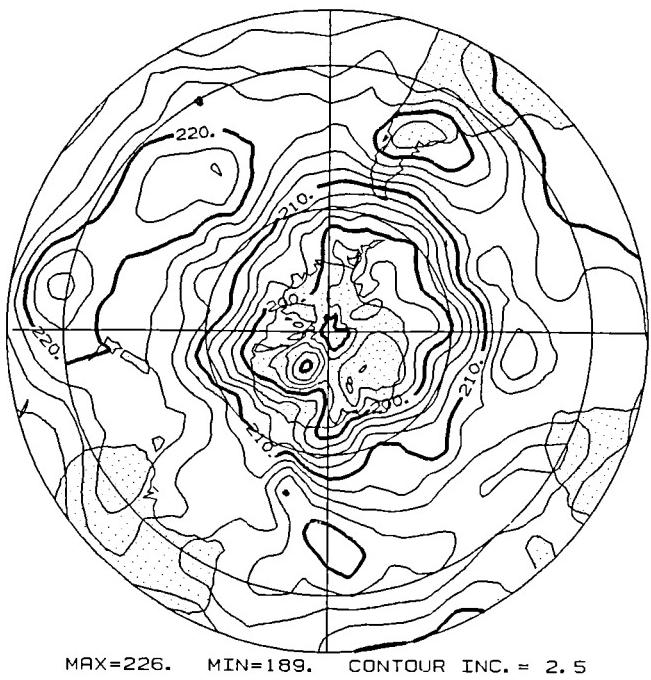


MAX= 396 MIN=-500 CONTOUR INC.=50

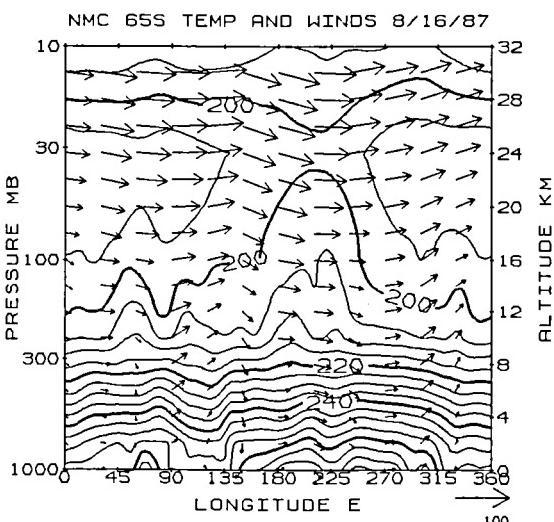
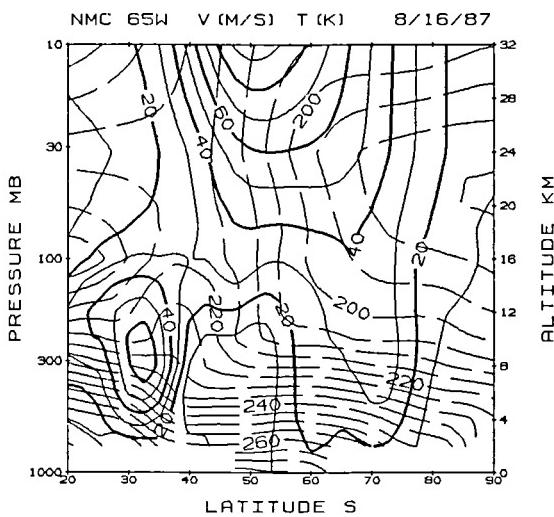
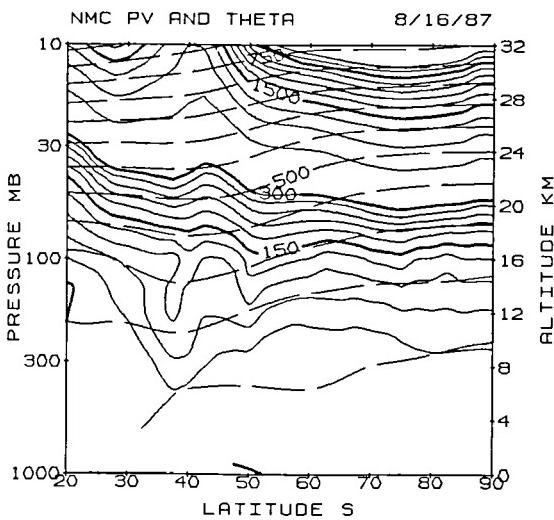
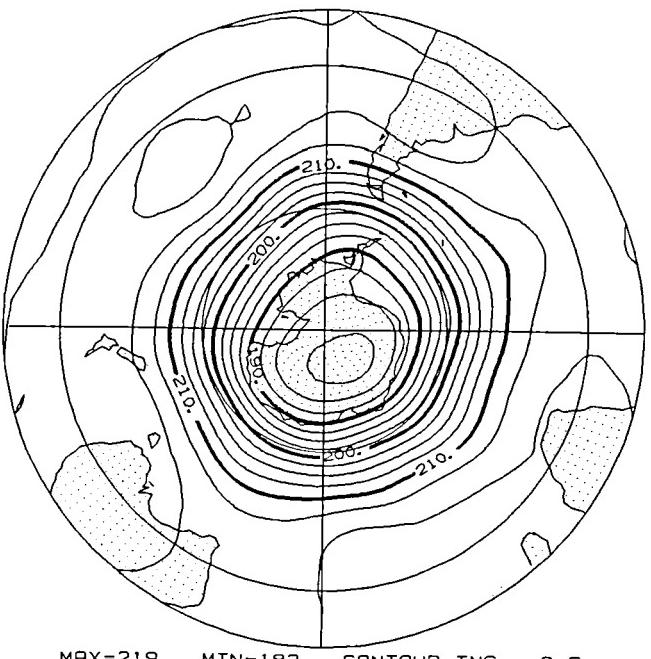
NMC 420K ERTEL POT VOR 8/16/87



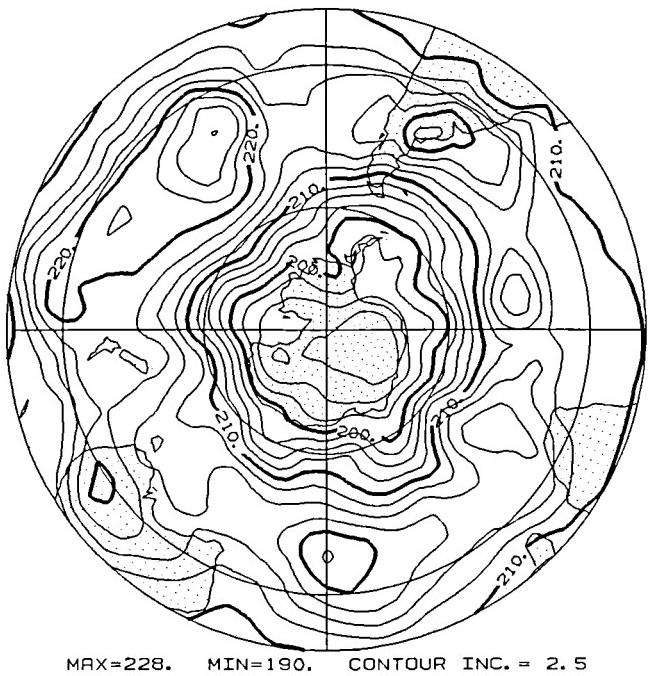
GLA 200-100 THICK. T O 8/16/87



NMC 50-30MB THICKNESS 8/16/87



NMC 200-100 THICK. T O 8/17/87



TOMS TOTAL OZONE

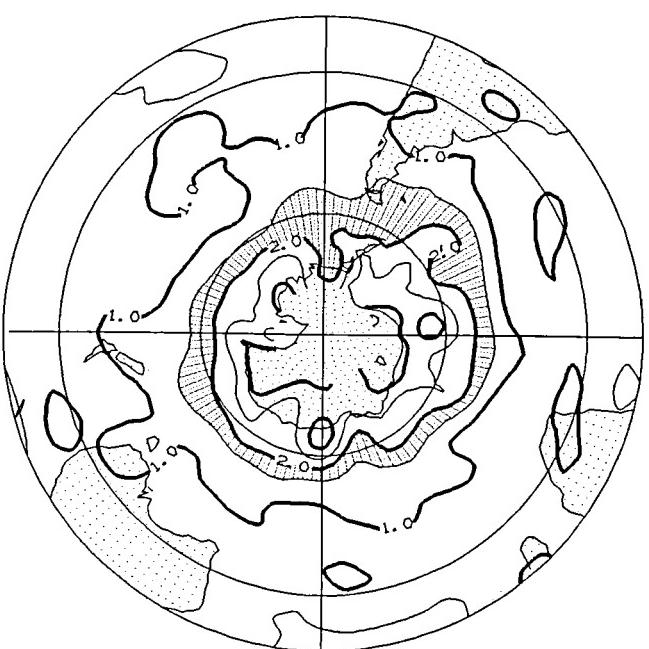
8/17/87



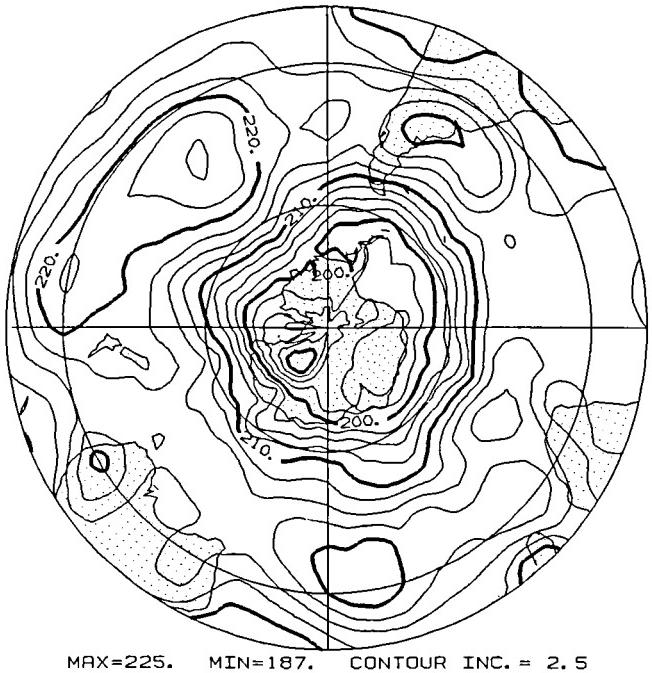
NMC 100MB HGT DEV. 8/17/87



NMC 420K ERTEL POT VOR 8/17/87

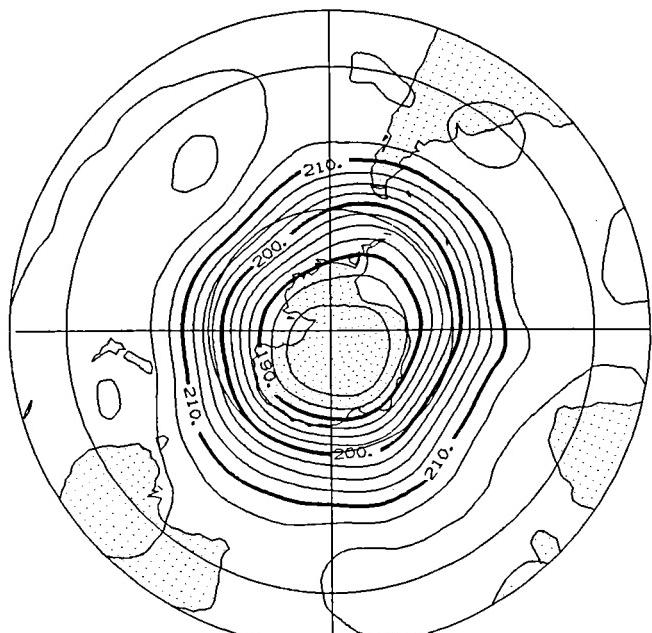


GLA 200-100 THICK. T 0 8/17/87



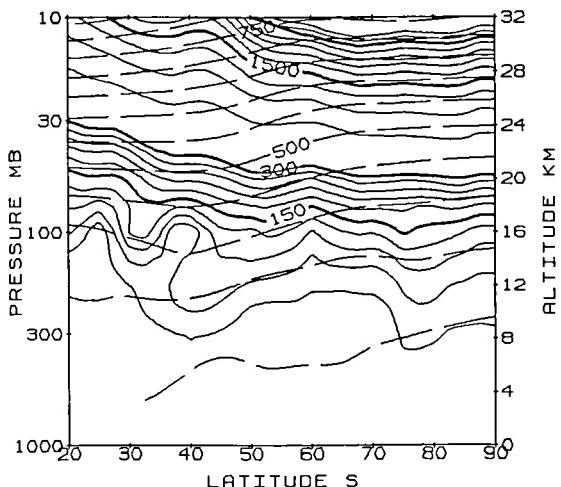
MAX=225. MIN=187. CONTOUR INC. = 2.5

NMC 50-30MB THICKNESS 8/17/87

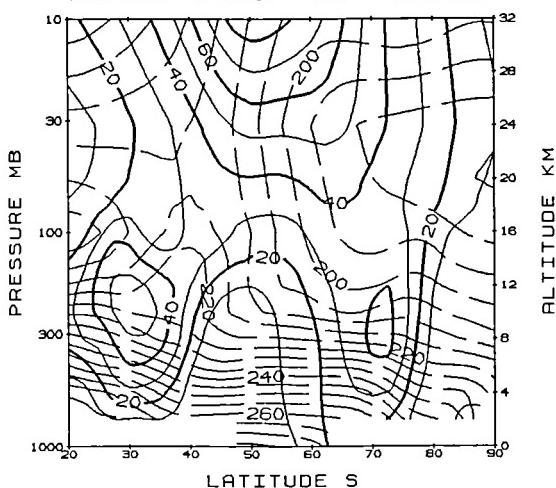


MAX=218. MIN=183. CONTOUR INC. = 2.5

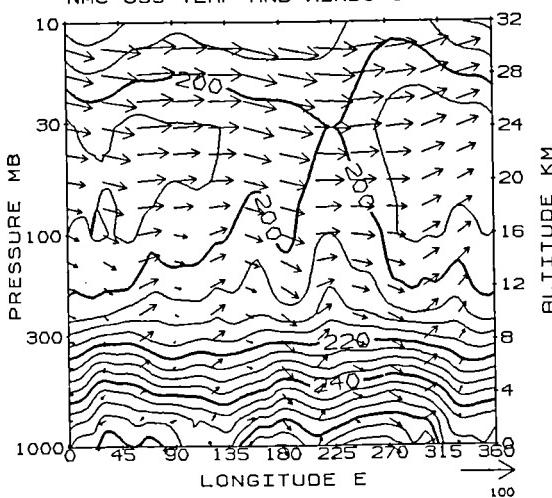
NMC PV AND THETA 8/17/87



NMC 65W V (M/S) T (K) 8/17/87



NMC 65S TEMP AND WINDS 8/17/87



NMC 200-100 THICK. T 0 8/18/87



MAX=226. MIN=188. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

8/18/87



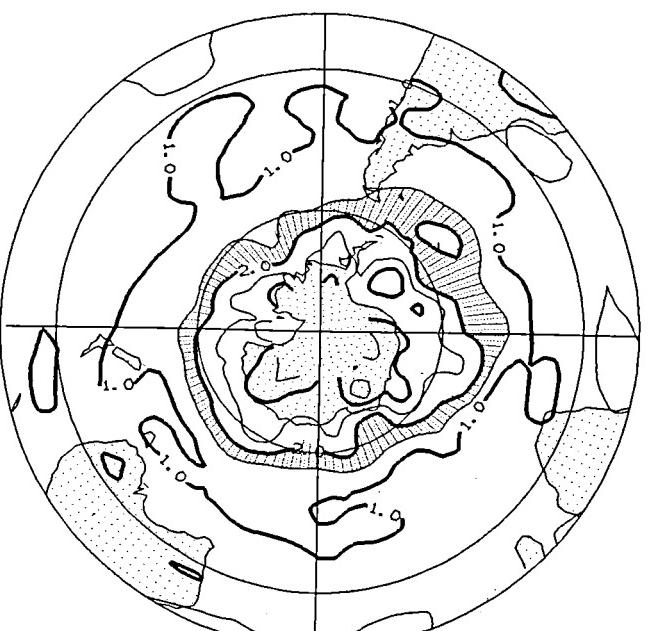
MAX=406. MIN=217. CONTOUR INC. = 25.

NMC 100MB HGT DEV. 8/18/87



MAX= 384 MIN=-500 CONTOUR INC. =50

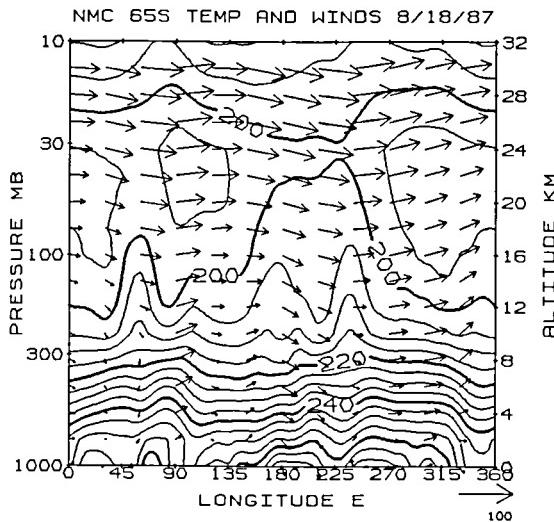
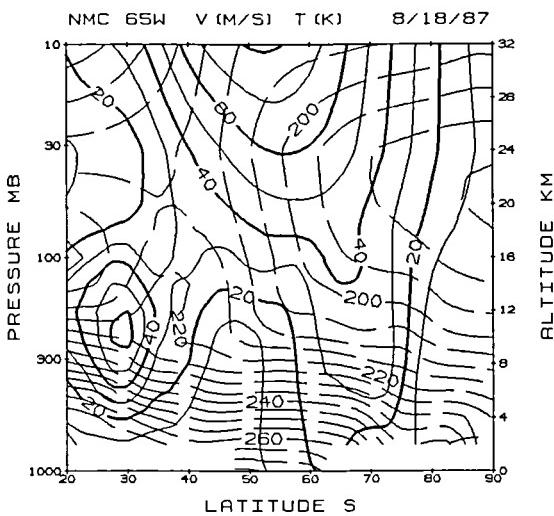
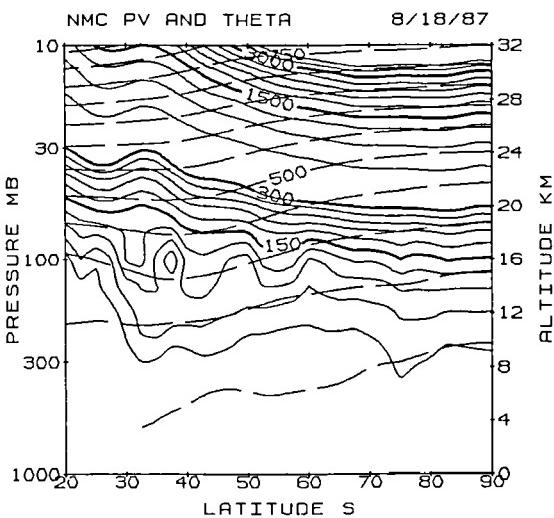
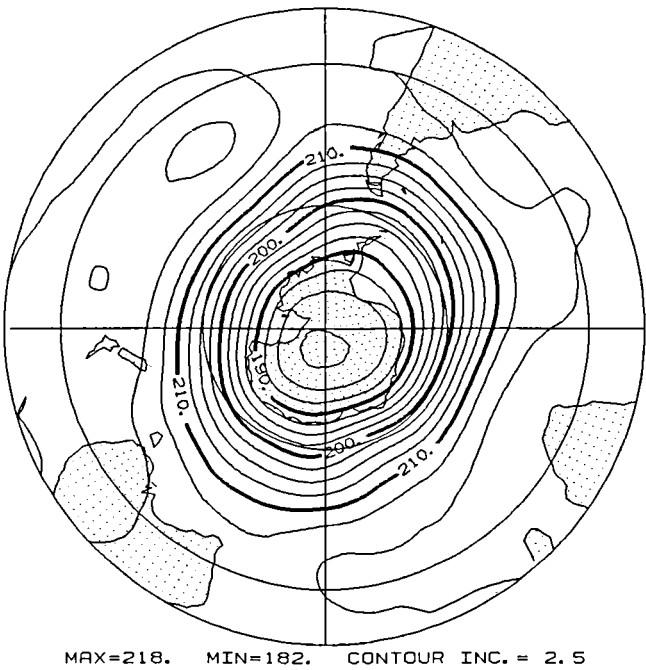
NMC 420K ERTEL POT VOR 8/18/87



GLA 200-100 THICK. T 0 8/18/87



NMC 50-30MB THICKNESS 8/18/87



NMC 200-100 THICK. T O 8/19/87



MAX=227. MIN=187. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

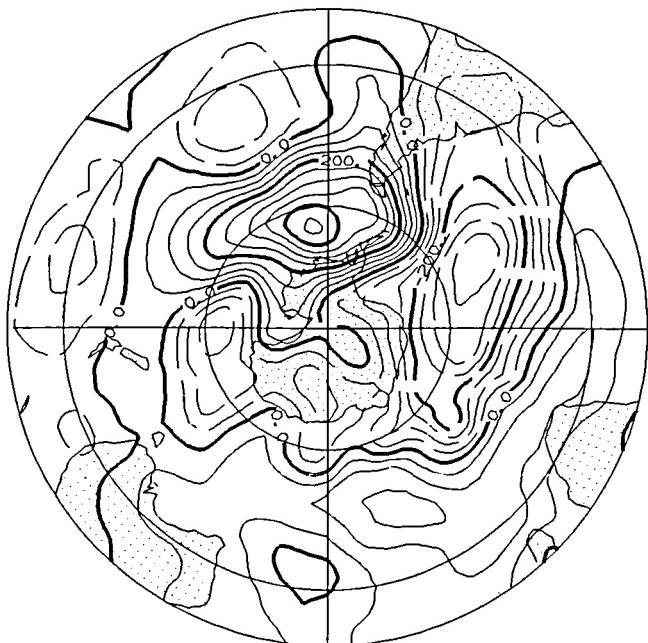
8/19/87



MAX=436. MIN=201. CONTOUR INC. = 25.

NMC 100MB HGT DEV.

8/19/87

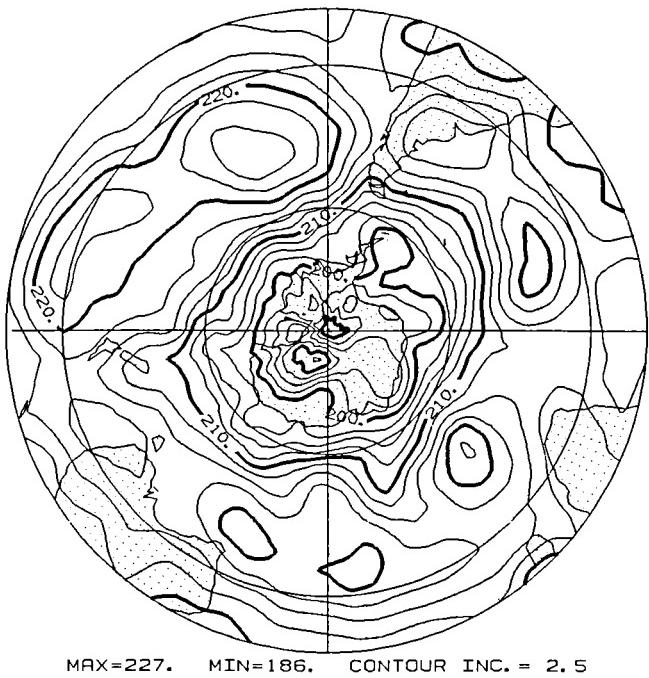


MAX= 460 MIN=-350 CONTOUR INC. =50

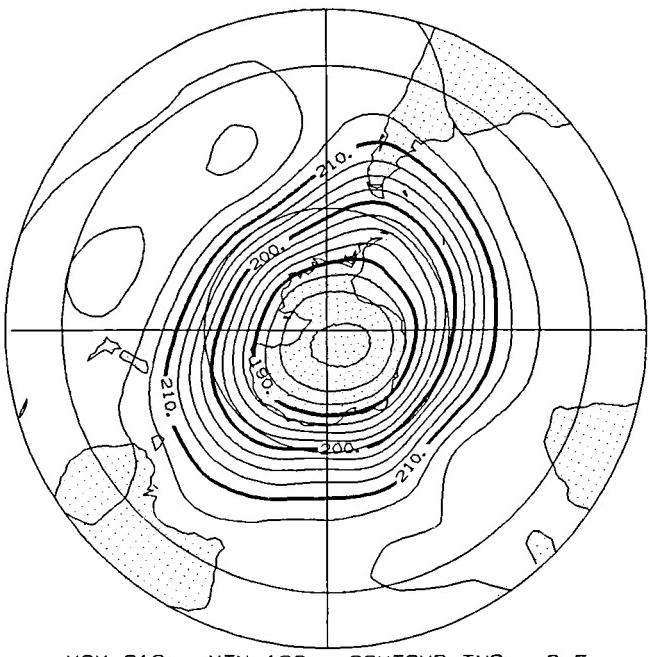
NMC 420K ERTEL POT VOR 8/19/87



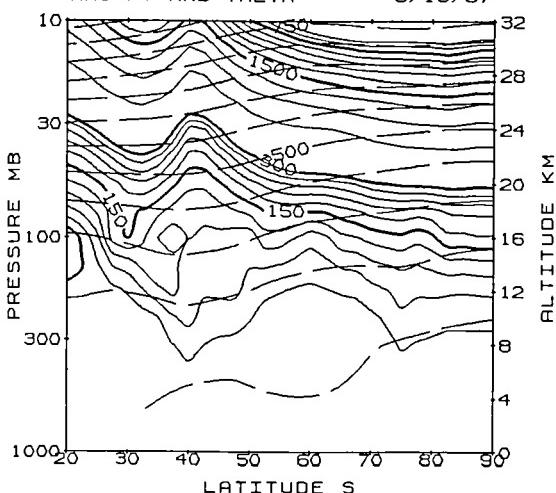
GLA 200-100 THICK. T O 8/19/87



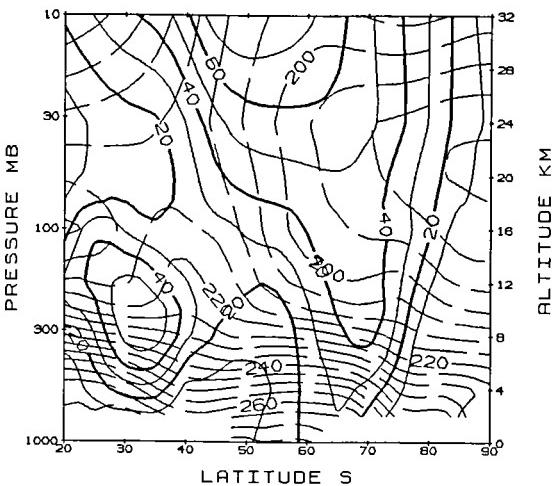
NMC 50-30MB THICKNESS 8/19/87



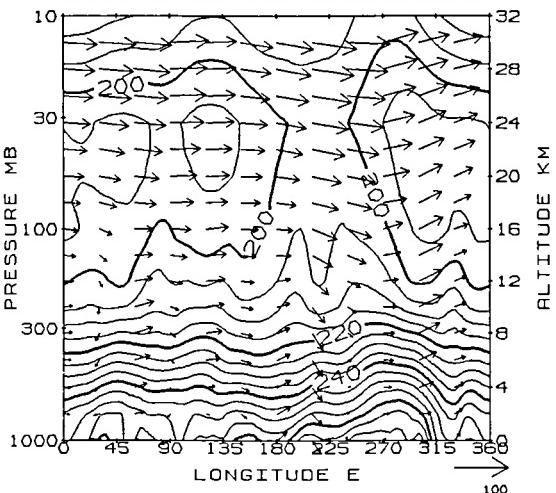
NMC PV AND THETA 8/19/87



NMC 65W V (M/S) T (K) 8/19/87



NMC 65S TEMP AND WINDS 8/19/87



NMC 200-100 THICK. T 0 8/20/87



MAX=227. MIN=188. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

8/20/87



MAX=415. MIN=218. CONTOUR INC. = 25.

NMC 100MB HGT DEV. 8/20/87

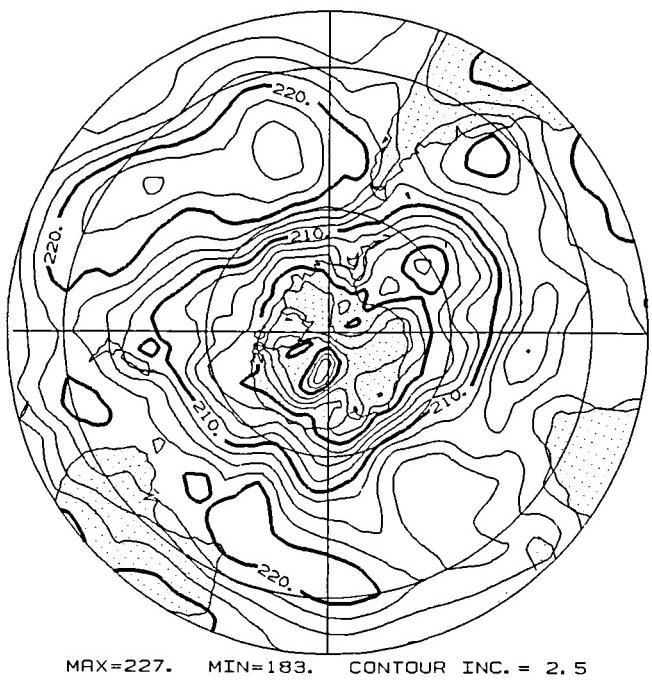


MAX= 480 MIN=-500 CONTOUR INC.=50

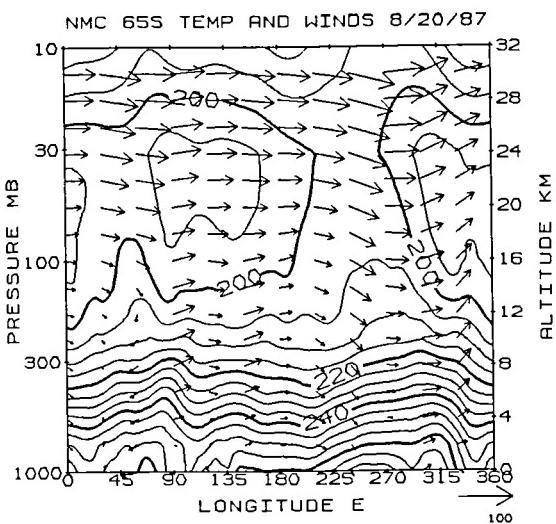
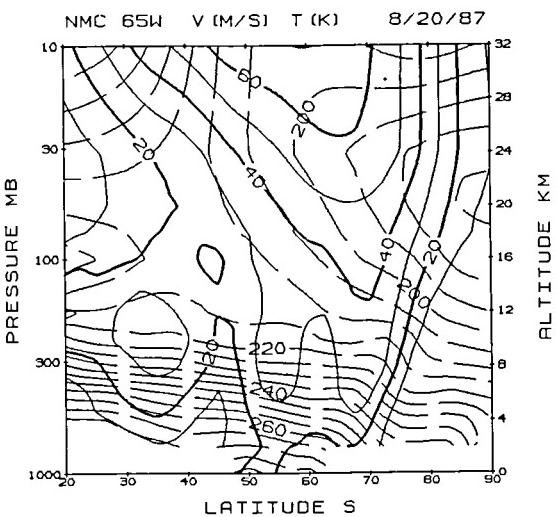
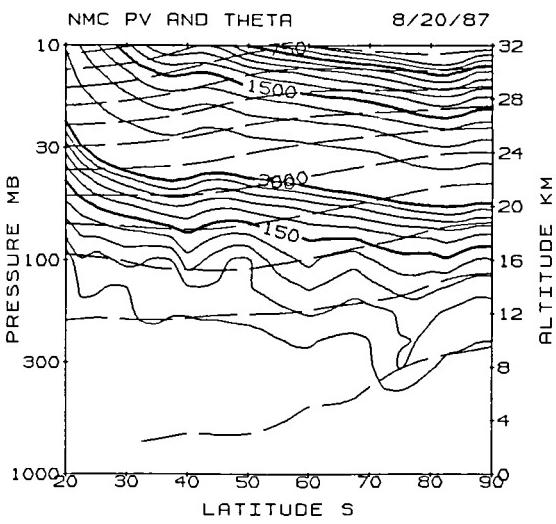
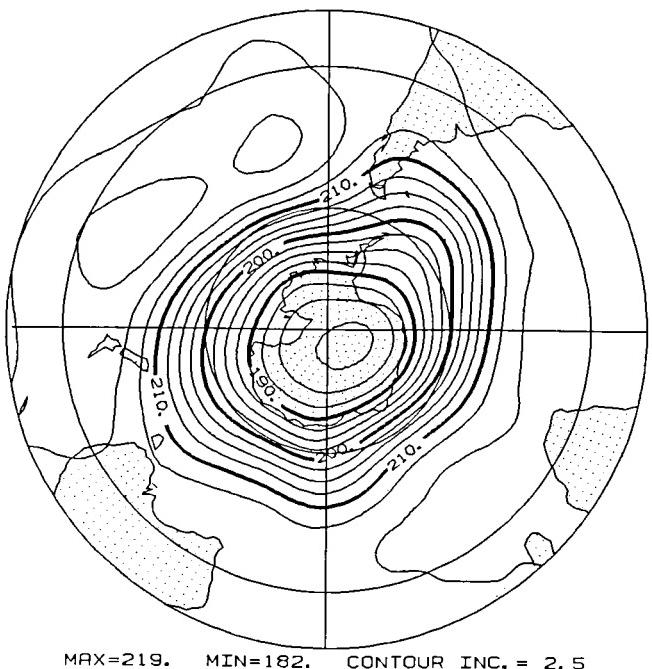
NMC 420K ERTEL POT VOR 8/20/87



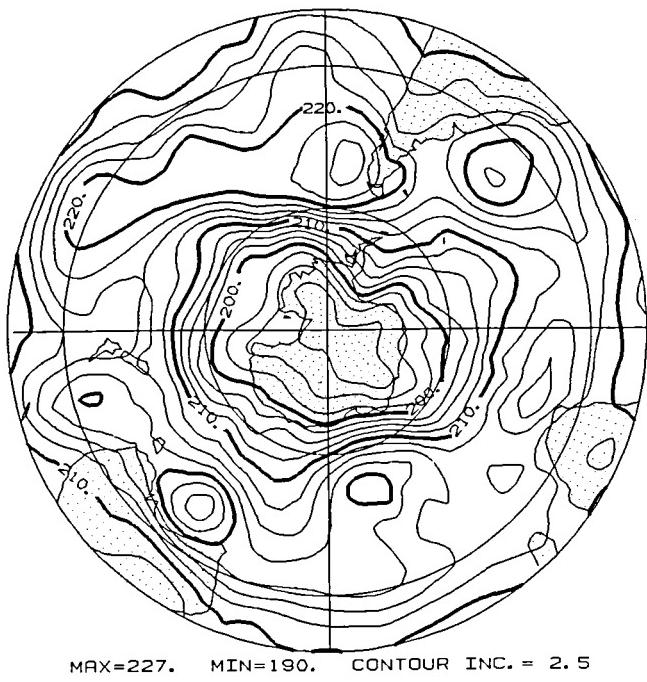
GLA 200-100 THICK. T 0 8/20/87



NMC 50-30MB THICKNESS 8/20/87

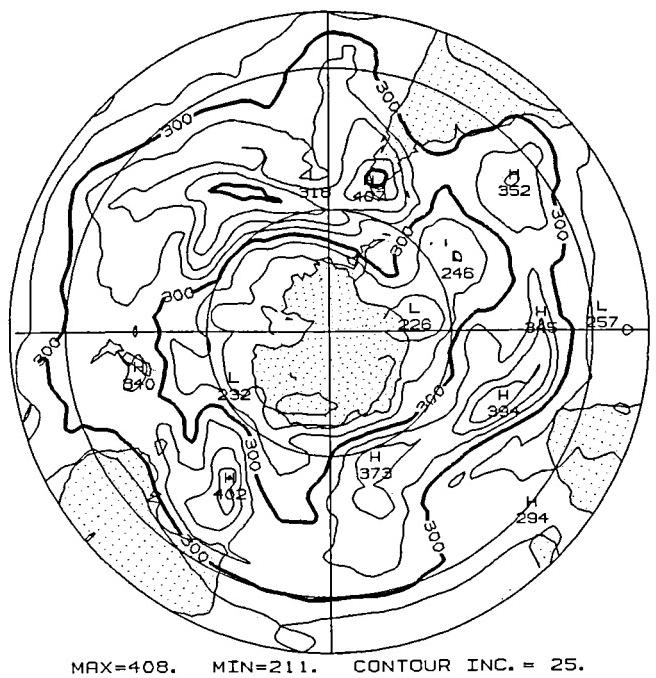


NMC 200-100 THICK. T O 8/21/87



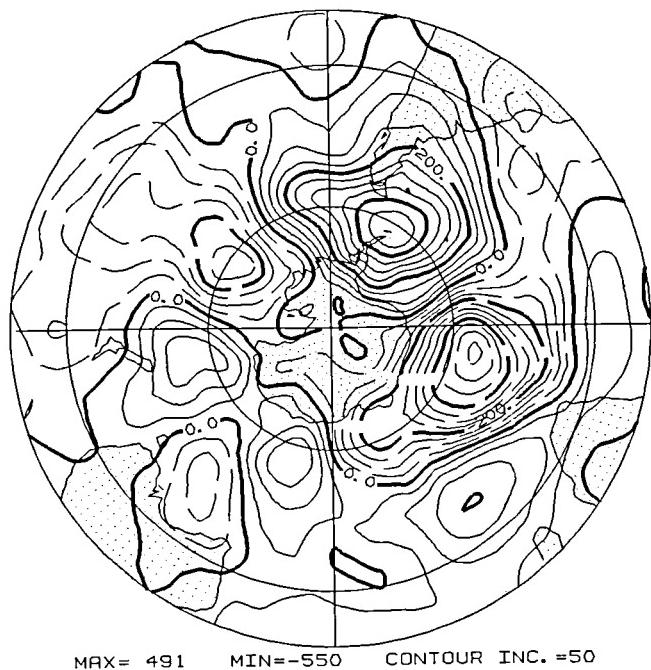
TOMS TOTAL OZONE

8/21/87



NMC 100MB HGT DEV.

8/21/87



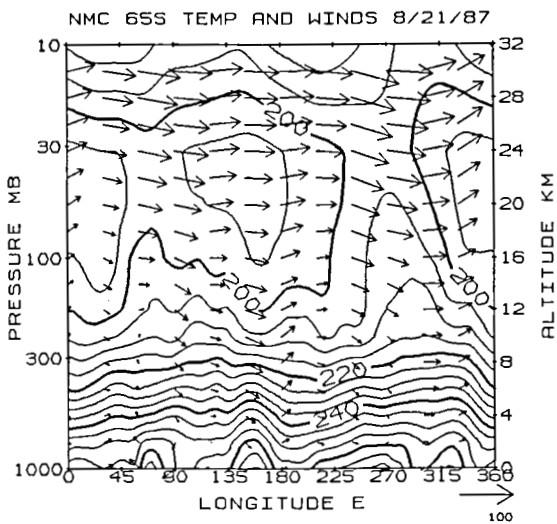
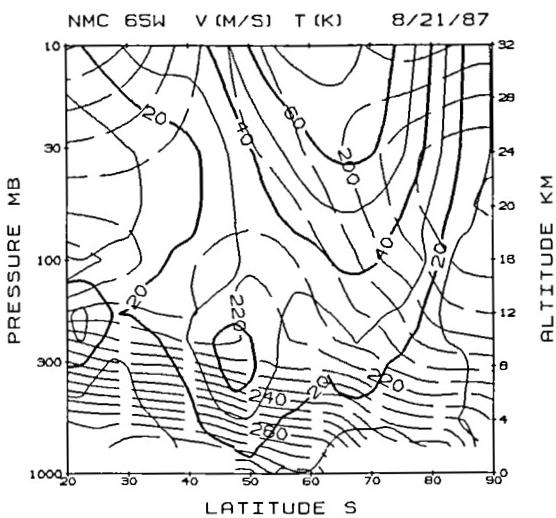
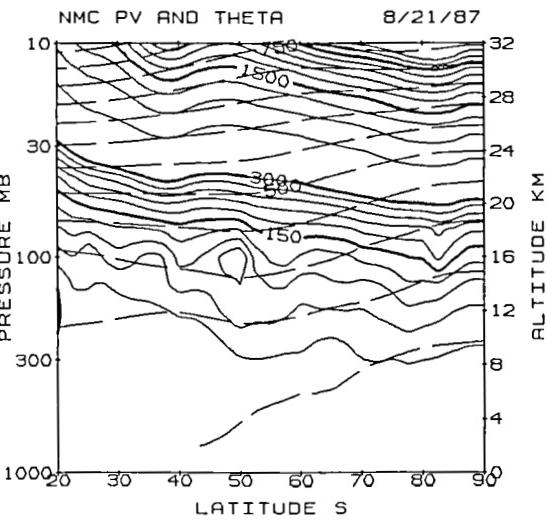
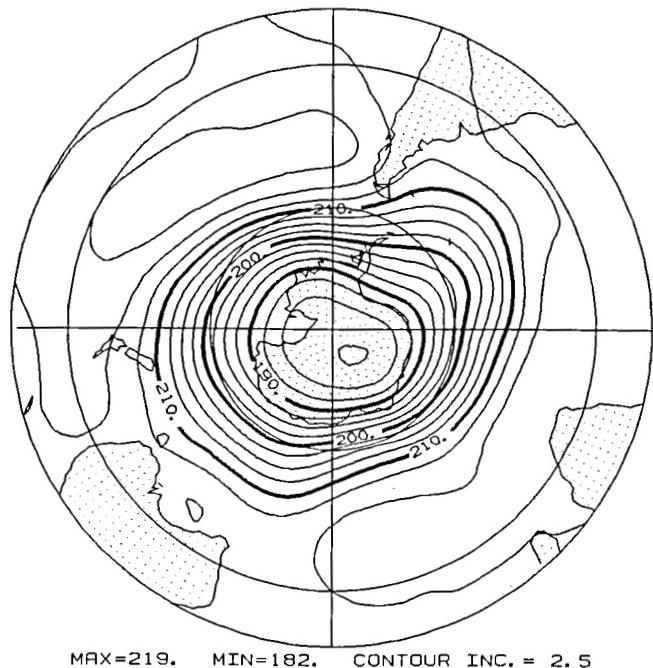
NMC 420K ERTEL POT VOR 8/21/87



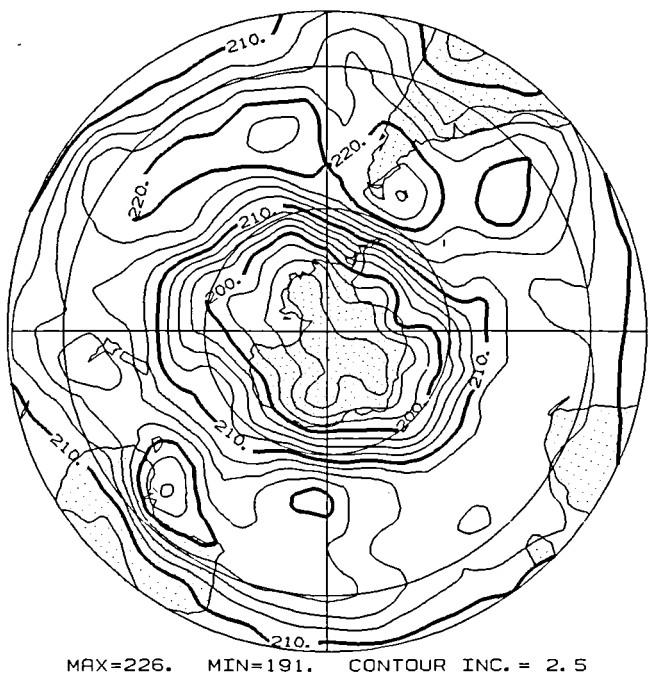
GLA 200-100 THICK. T O 8/21/87



NMC 50-30MB THICKNESS 8/21/87



NMC 200-100 THICK. T 0 8/22/87



MAX=226. MIN=191. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

8/22/87



MAX=426. MIN=219. CONTOUR INC. = 25.

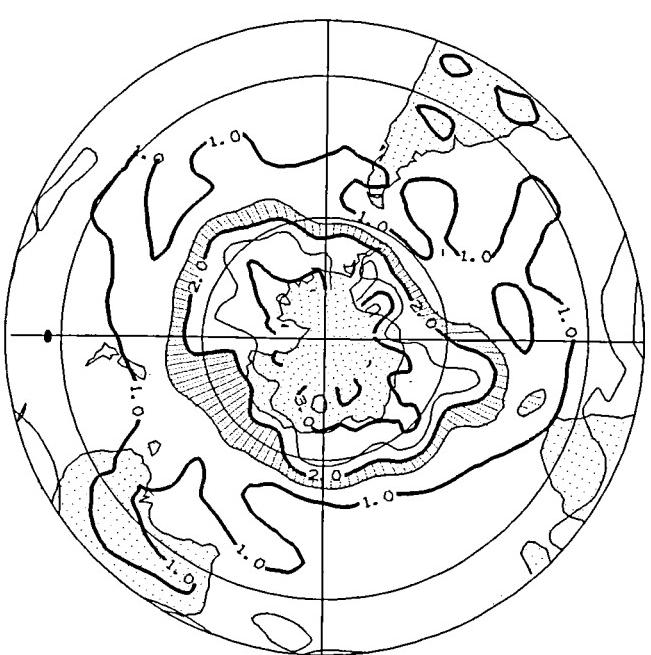
NMC 100MB HGT DEV.

8/22/87

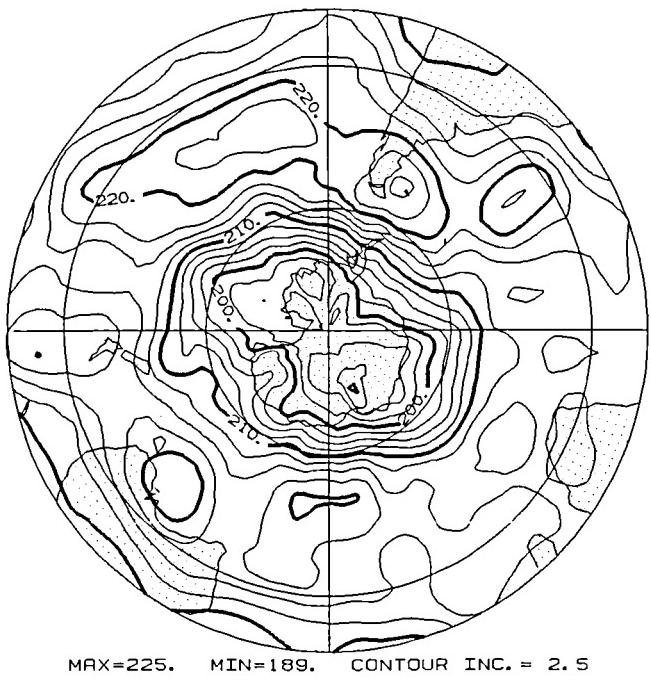


MAX= 456 MIN=-500 CONTOUR INC.=50

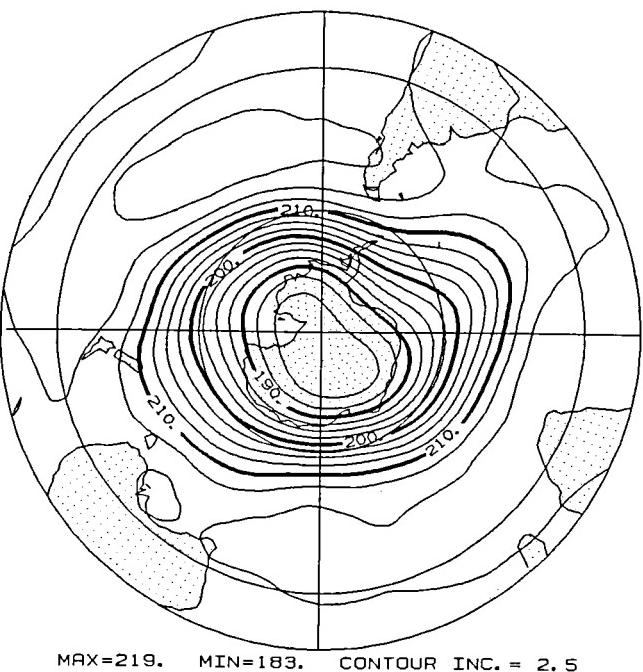
NMC 420K ERTEL POT VOR 8/22/87



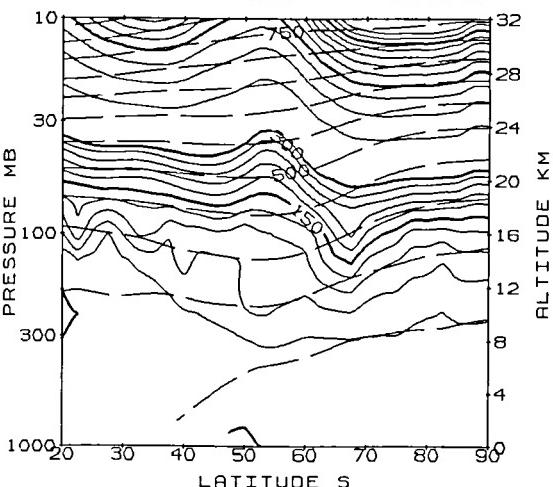
GLA 200-100 THICK. T 0 8/22/87



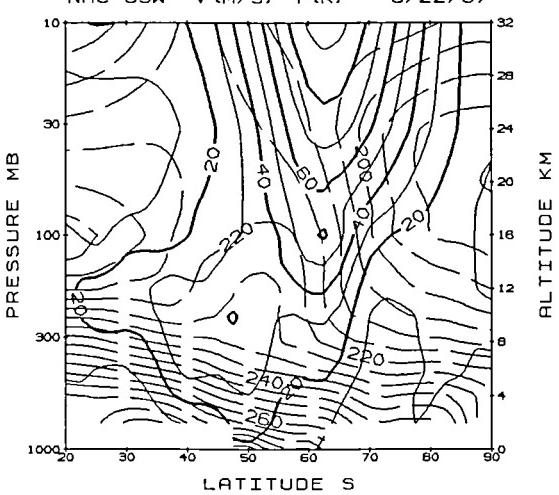
NMC 50-30MB THICKNESS 8/22/87



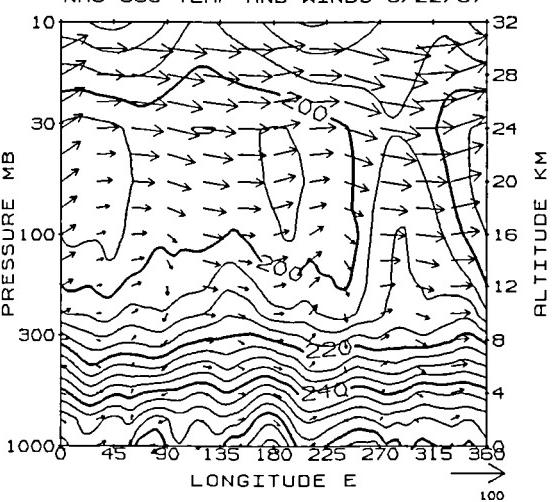
NMC PV AND THETA 8/22/87



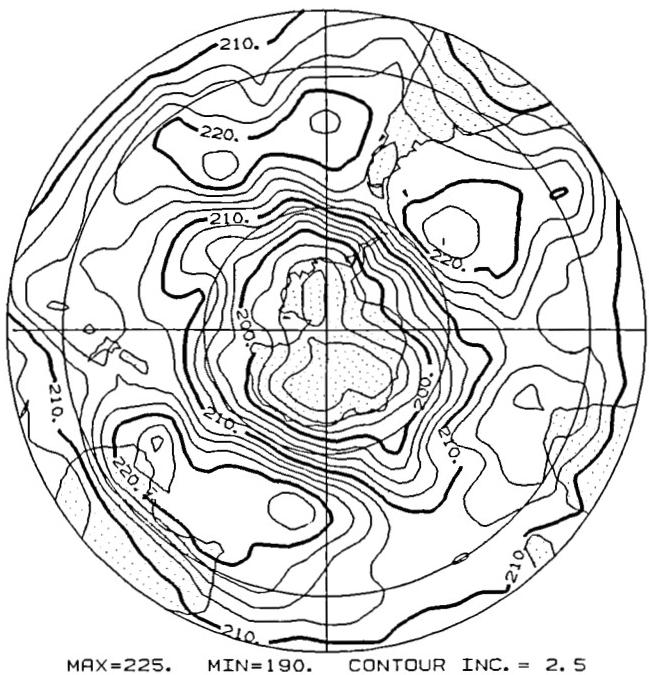
NMC 65W V (M/S) T (K) 8/22/87



NMC 65S TEMP AND WINDS 8/22/87

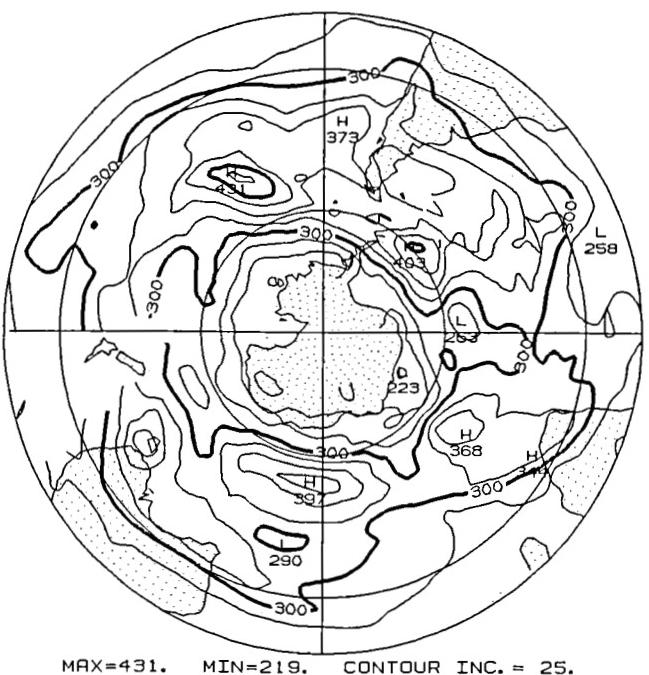


NMC 200-100 THICK. T 0 8/23/87

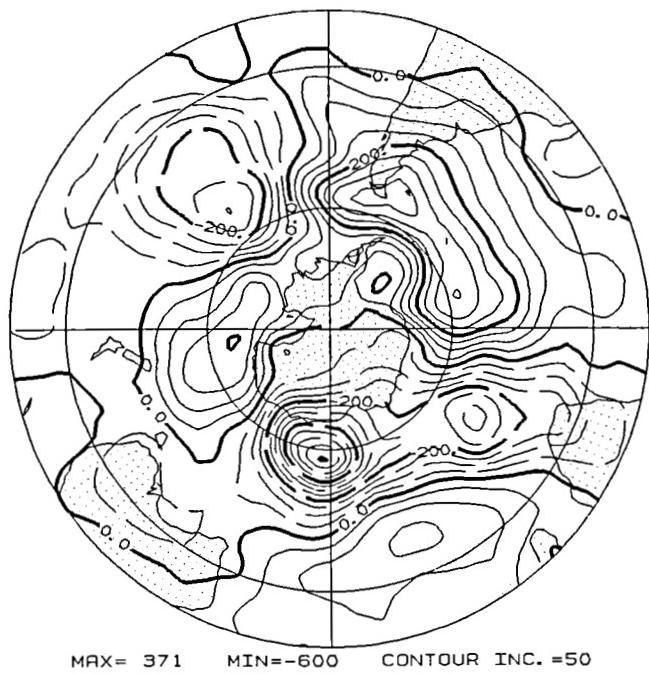


TOMS TOTAL OZONE

8/23/87



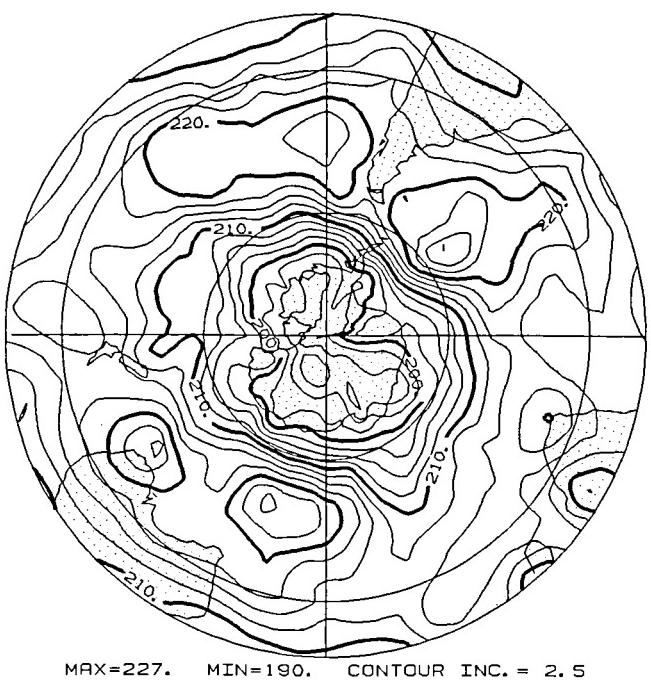
NMC 100MB HGT DEV. 8/23/87



NMC 420K ERTEL POT VOR 8/23/87

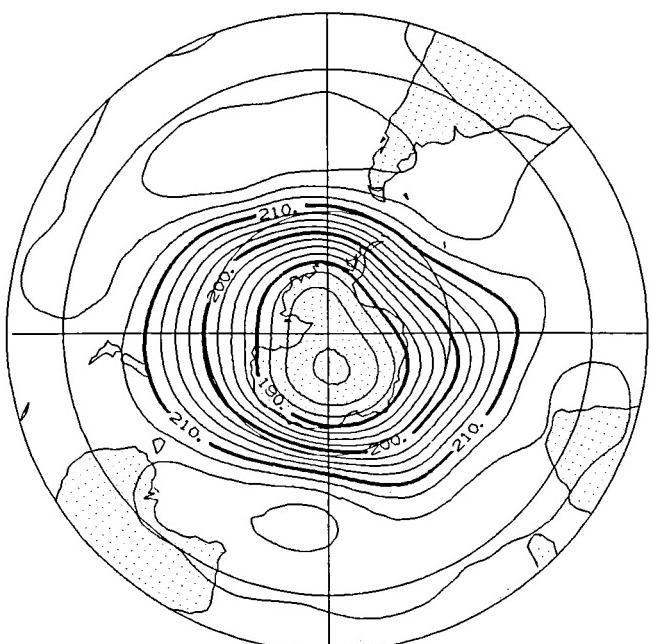


GLA 200-100 THICK. T 0 8/23/87



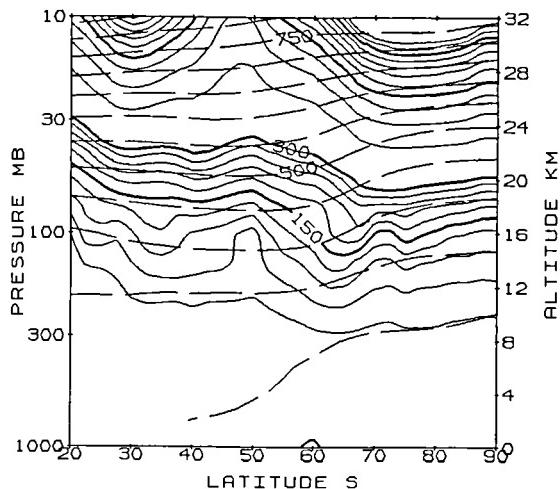
MAX=227. MIN=190. CONTOUR INC. = 2.5

NMC 50-30MB THICKNESS 8/23/87

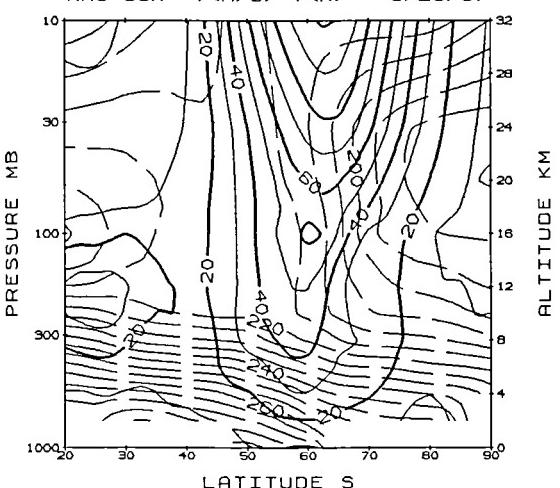


MAX=220. MIN=182. CONTOUR INC. = 2.5

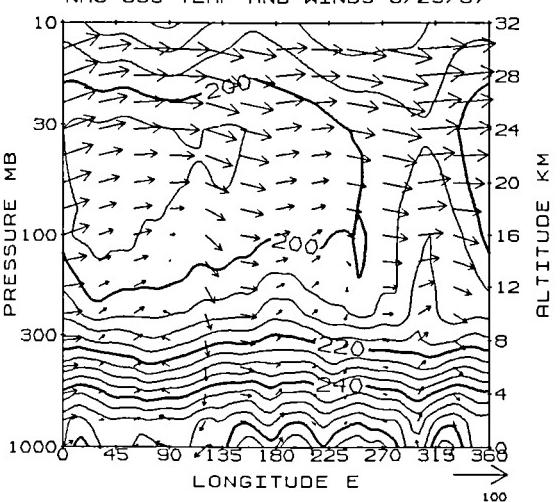
NMC PV AND THETA 8/23/87



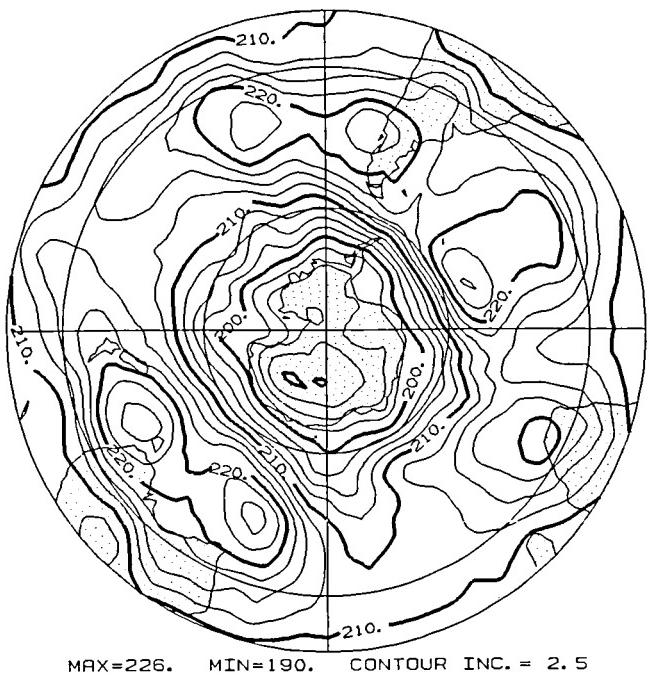
NMC 65W V (M/S) T (K) 8/23/87



NMC 65S TEMP AND WINDS 8/23/87

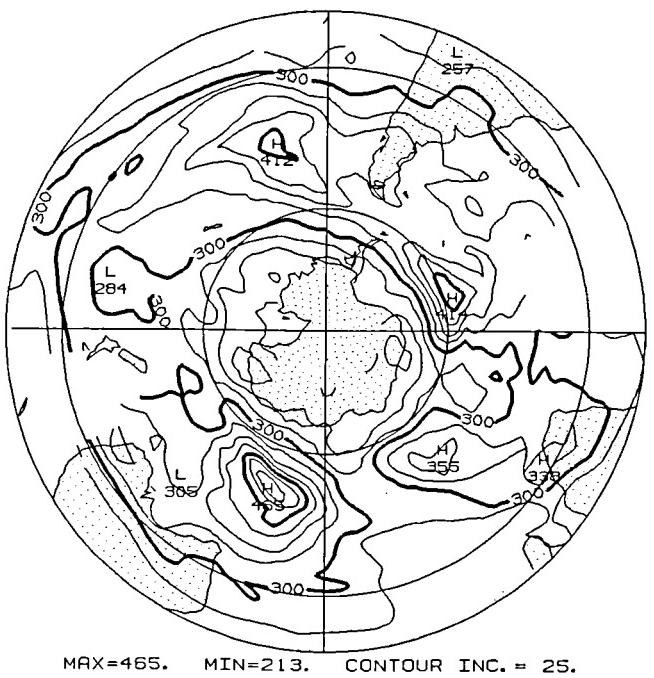


NMC 200-100 THICK. T O 8/24/87



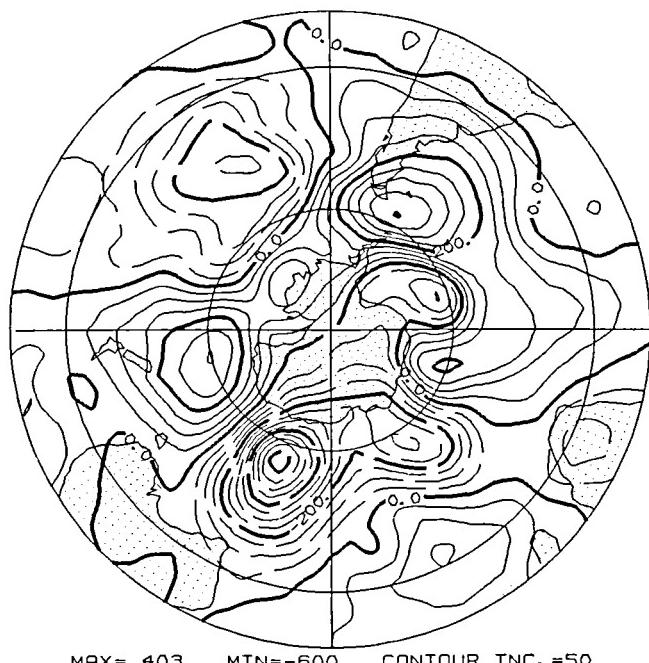
TOMS TOTAL OZONE

8/24/87



NMC 100MB HGT DEV.

8/24/87



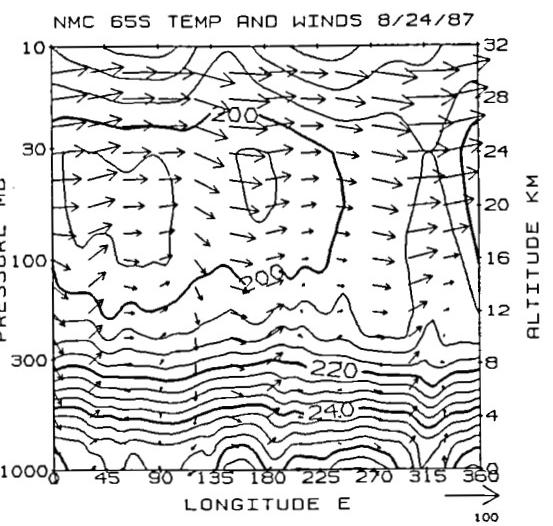
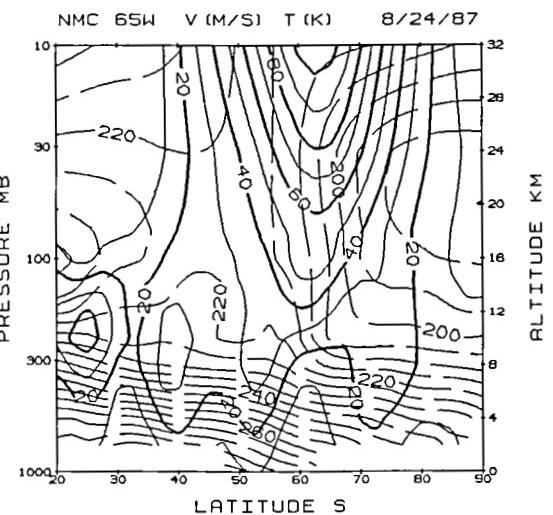
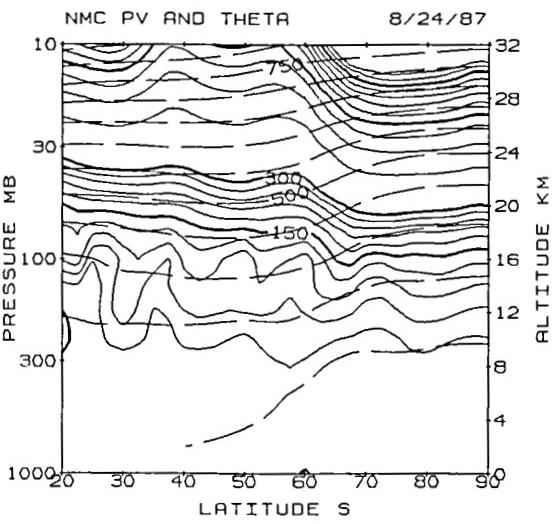
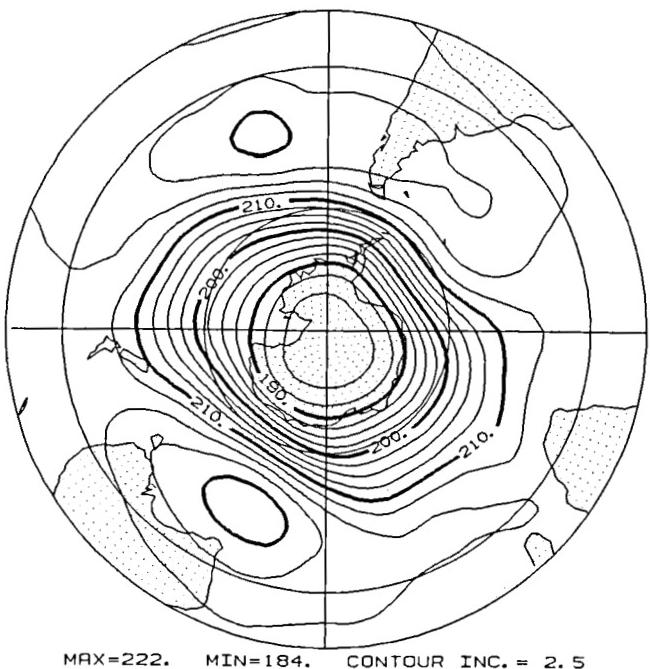
NMC 420K ERTEL POT VOR 8/24/87



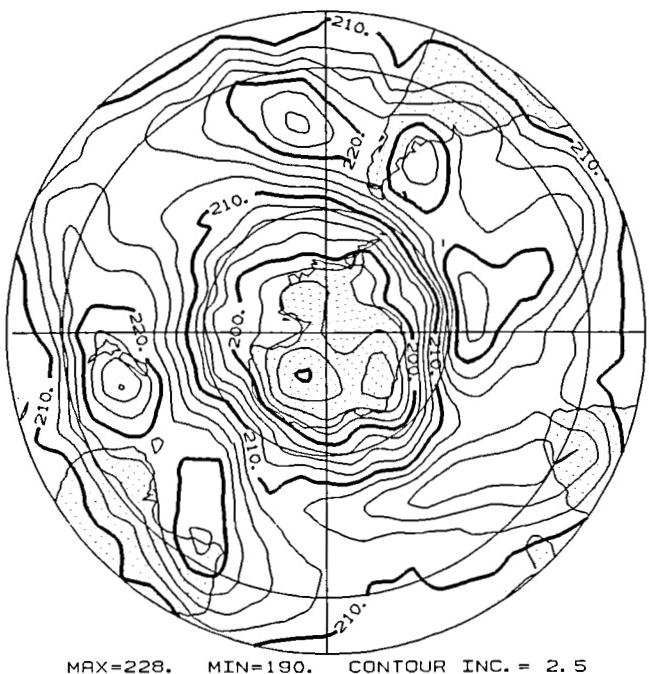
GLA 200-100 THICK. T 0 8/24/87



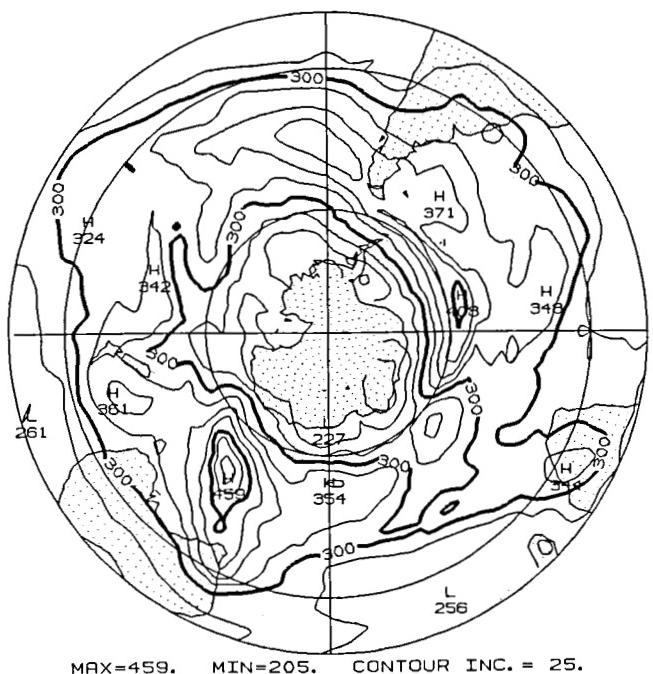
NMC 50-30MB THICKNESS 8/24/87



NMC 200-100 THICK. T 0 8/25/87



TOMS TOTAL OZONE



NMC 100MB HGT DEV.

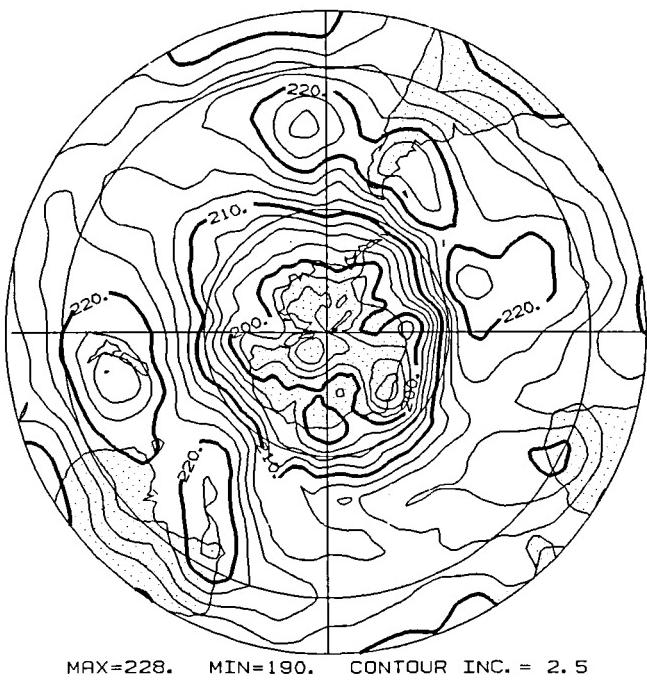


8/25/87

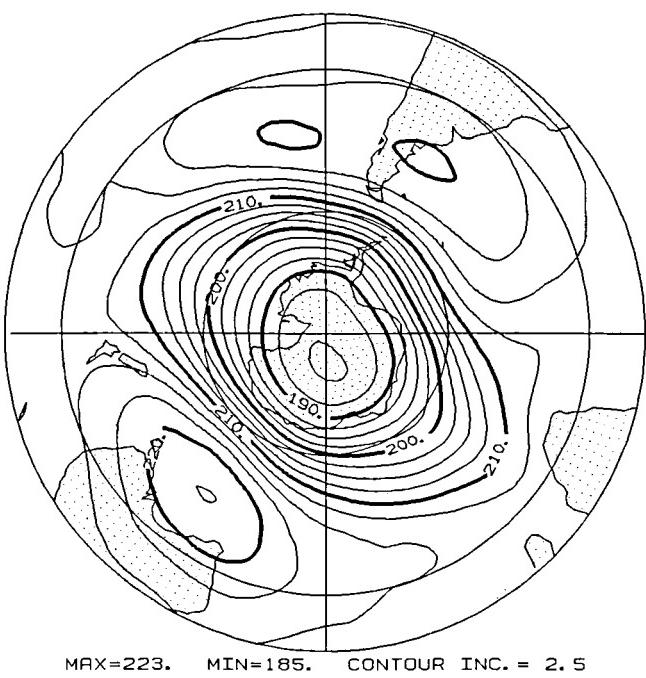
NMC 420K ERTEL POT VOR 8/25/87



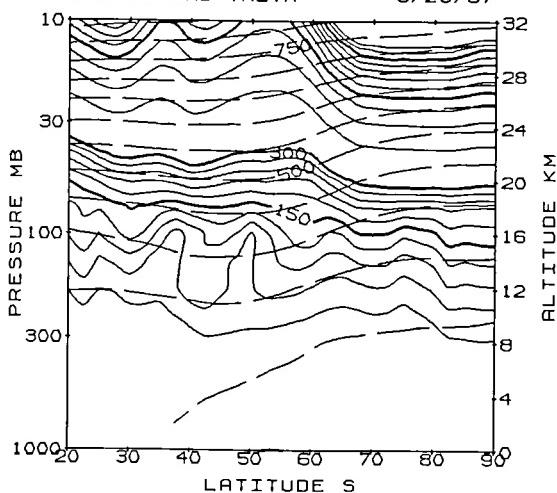
GLA 200-100 THICK. T 0 8/25/87



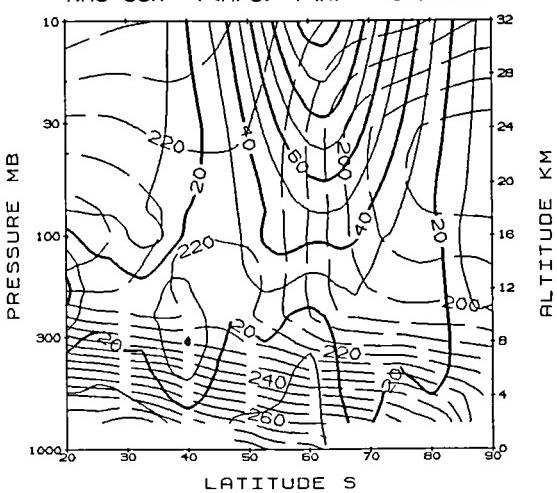
NMC 50-30MB THICKNESS 8/25/87



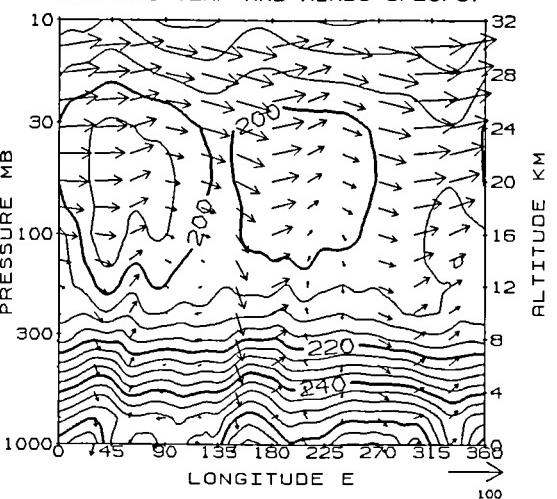
NMC PV AND THETA 8/25/87



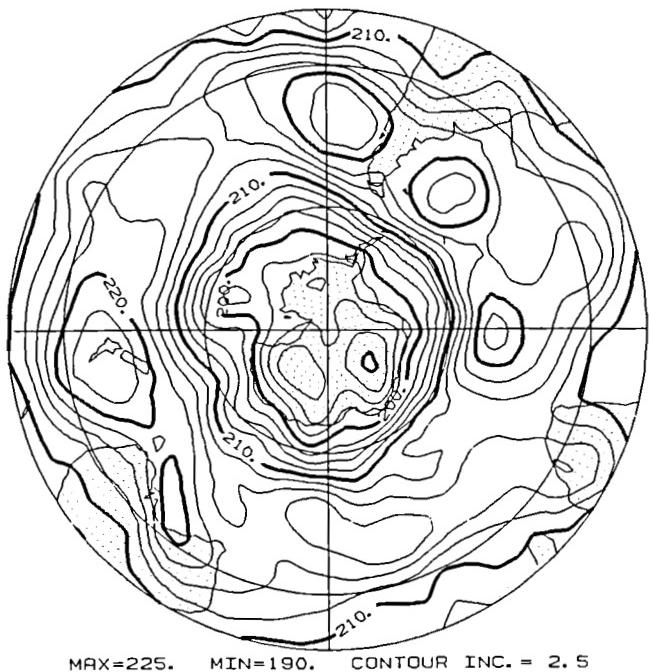
NMC 65W V (M/S) T (K) 8/25/87



NMC 65S TEMP AND WINDS 8/25/87



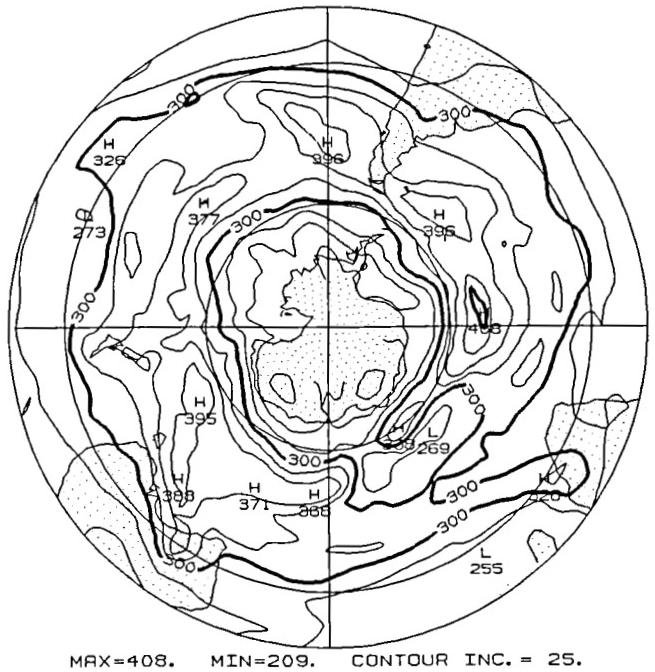
NMC 200-100 THICK. T 0 8/26/87



MAX=225. MIN=190. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

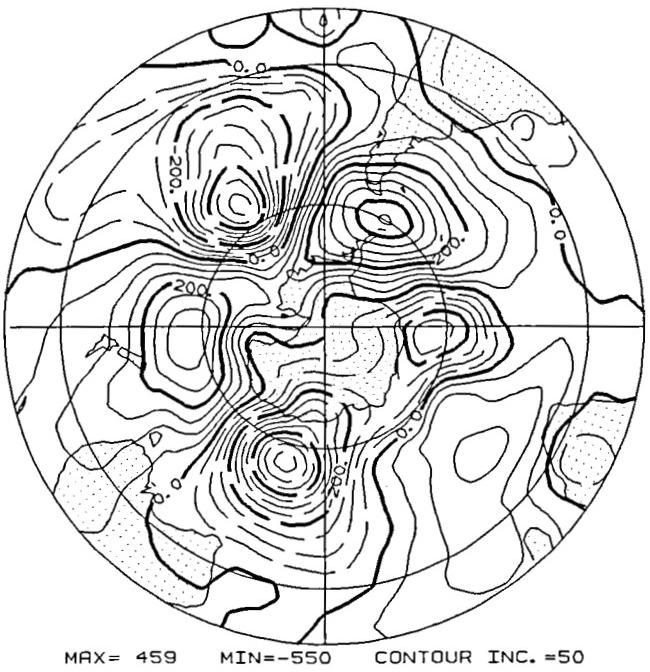
8/26/87



MAX=408. MIN=209. CONTOUR INC. = 25.

NMC 100MB HGT DEV.

8/26/87

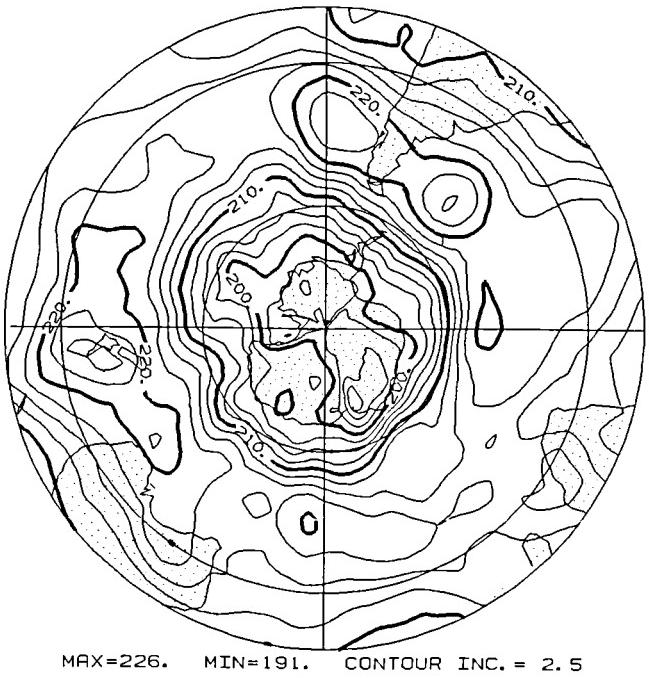


MAX= 459 MIN=-550 CONTOUR INC.=50

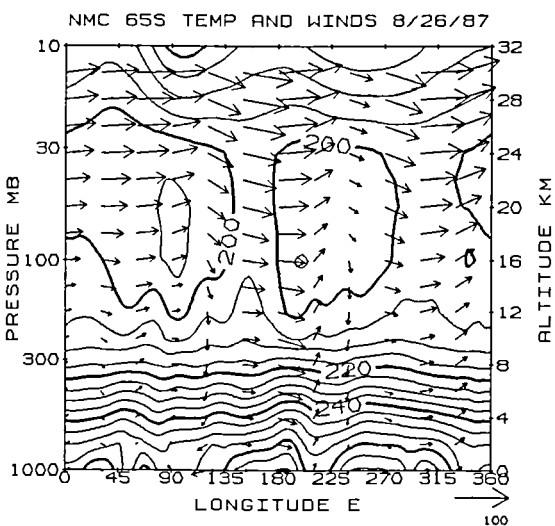
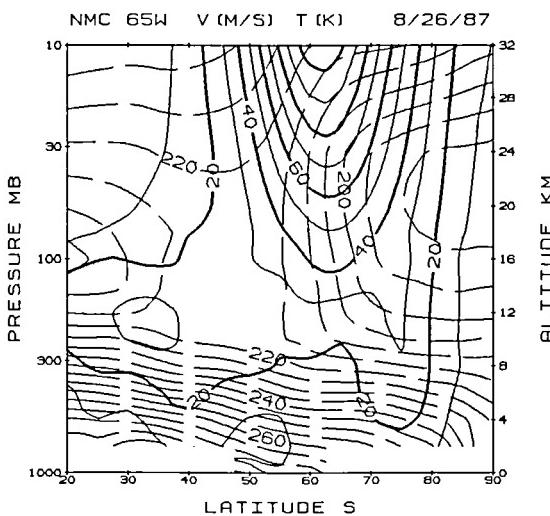
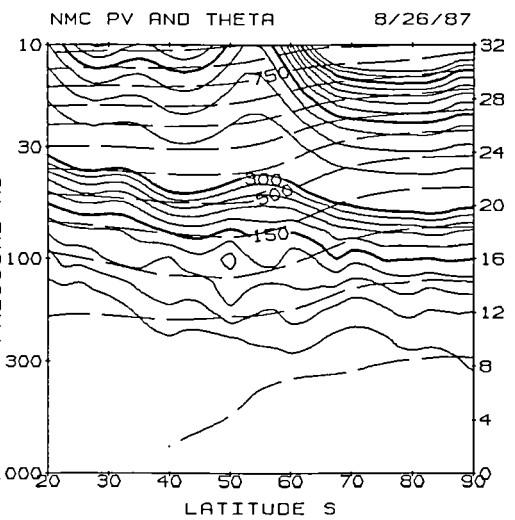
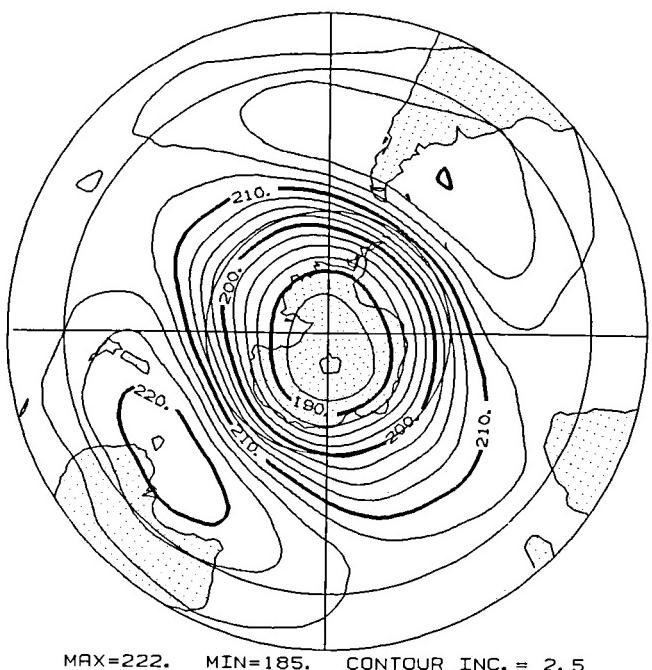
NMC 420K ERTEL POT VOR 8/26/87



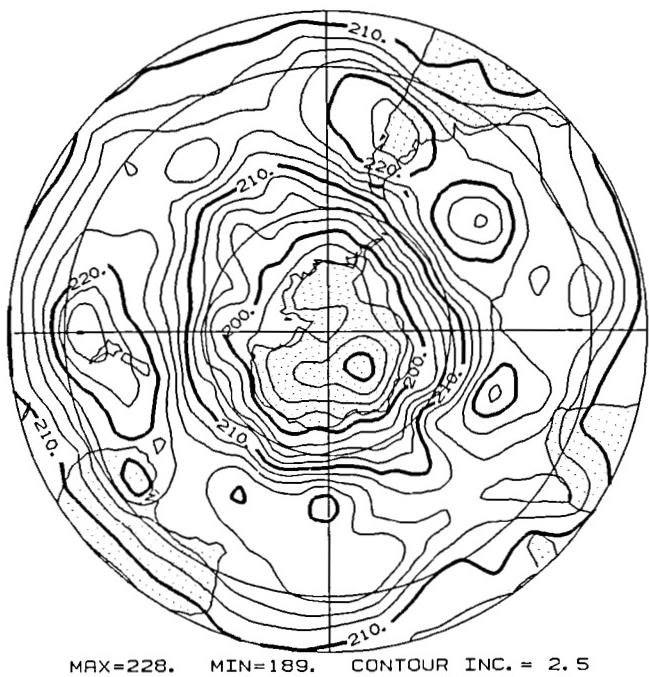
GLA 200-100 THICK. T O 8/26/87



NMC 50-30MB THICKNESS 8/26/87

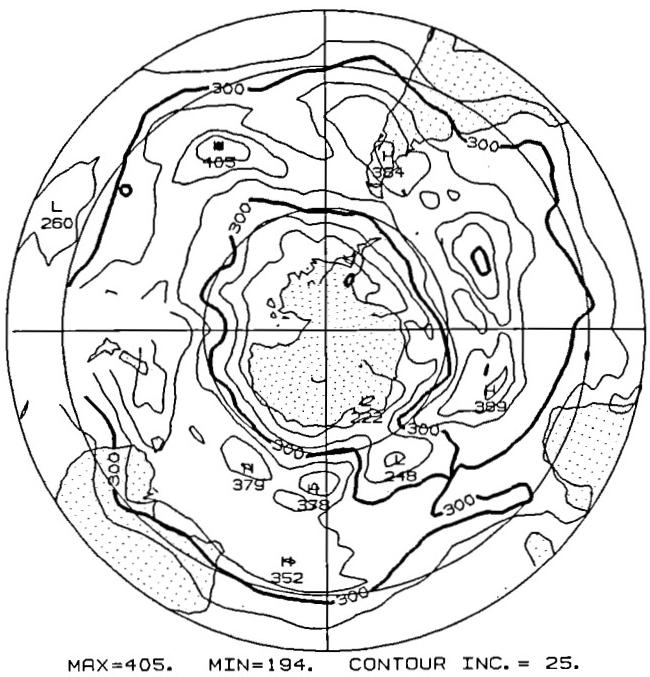


NMC 200-100 THICK. T 0 8/27/87



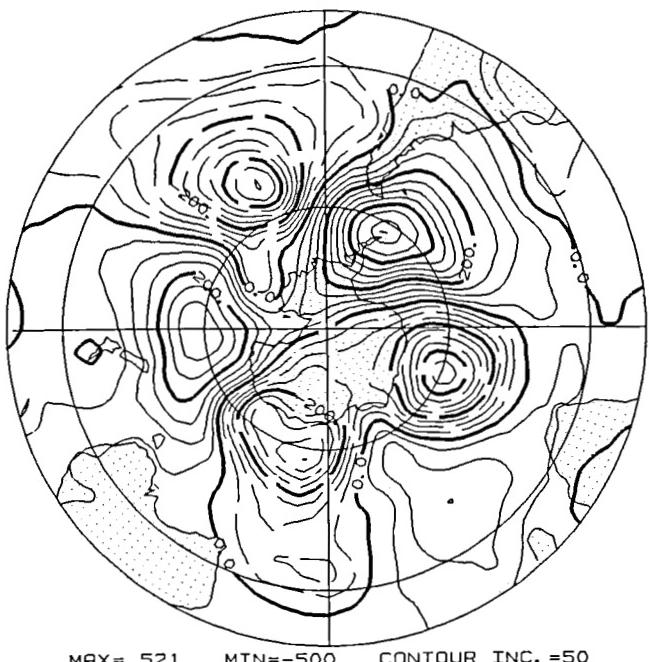
TOMS TOTAL OZONE

8/27/87



NMC 100MB HGT DEV.

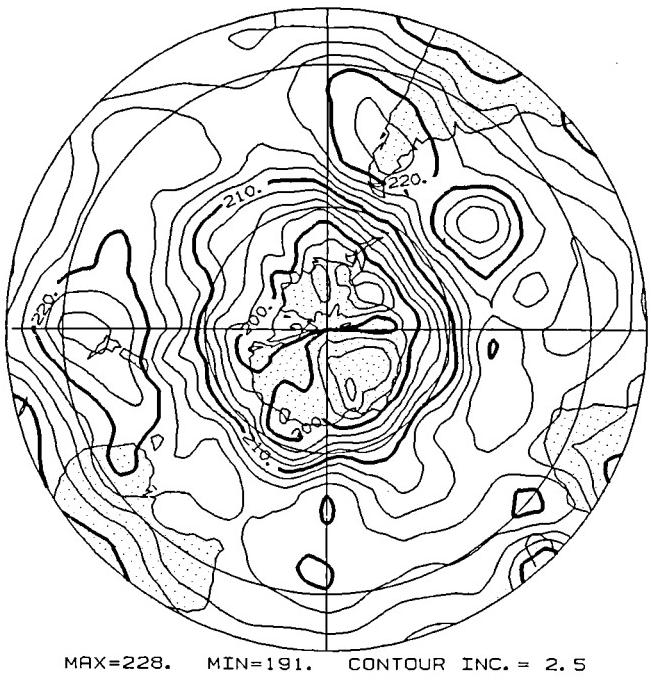
8/27/87



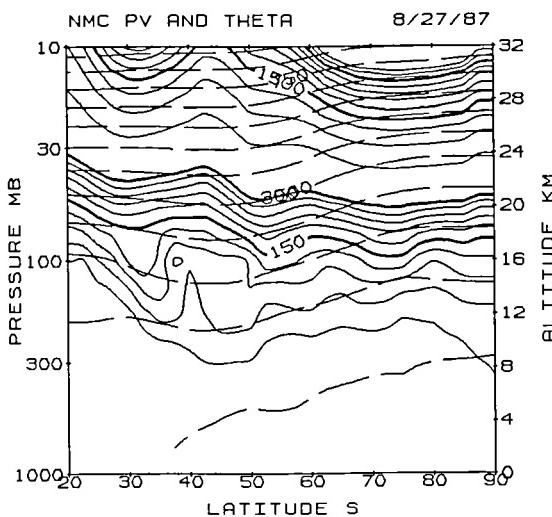
NMC 420K ERTEL POT VOR 8/27/87



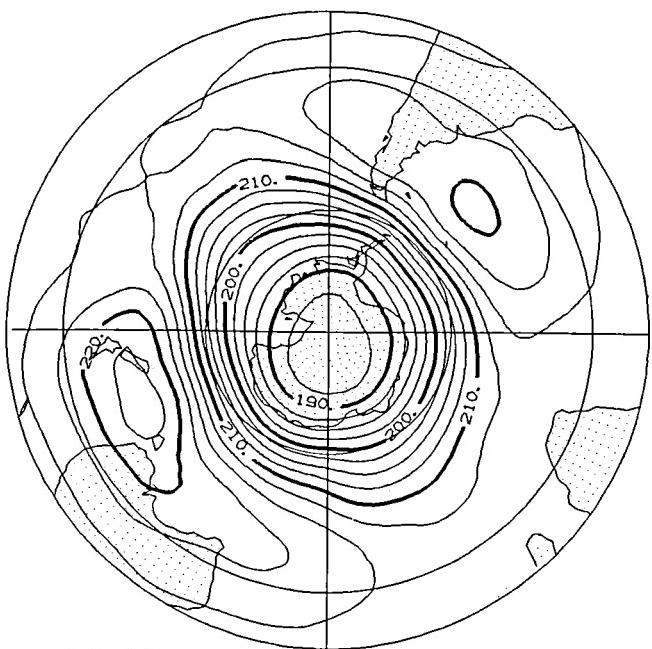
GLA 200-100 THICK. T 0 8/27/87



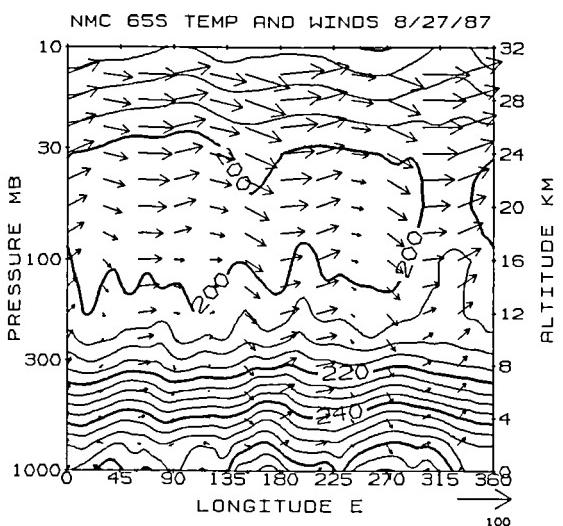
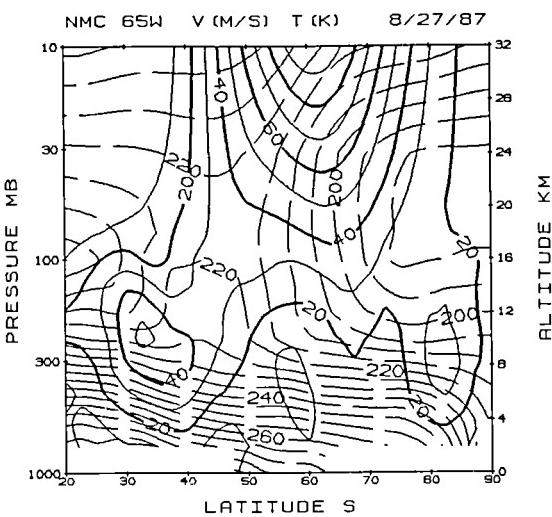
MAX=228. MIN=191. CONTOUR INC. = 2.5



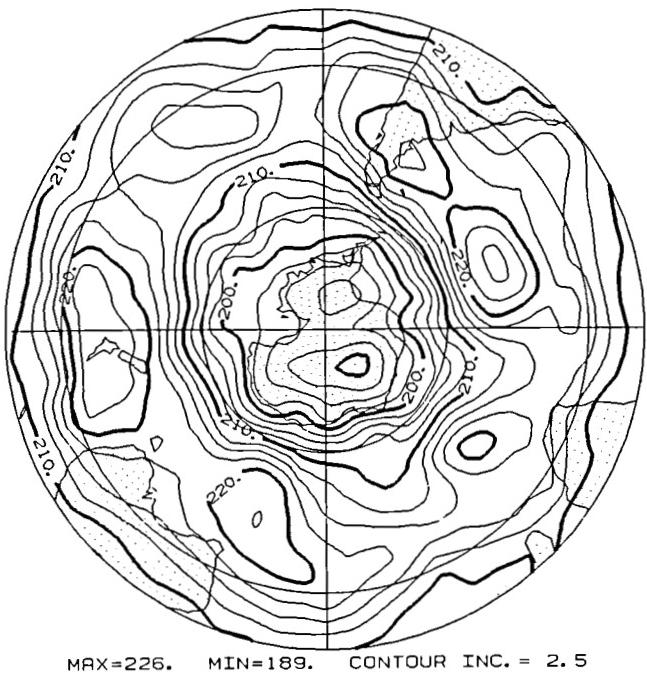
NMC 50-30MB THICKNESS 8/27/87



MAX=224. MIN=186. CONTOUR INC. = 2.5

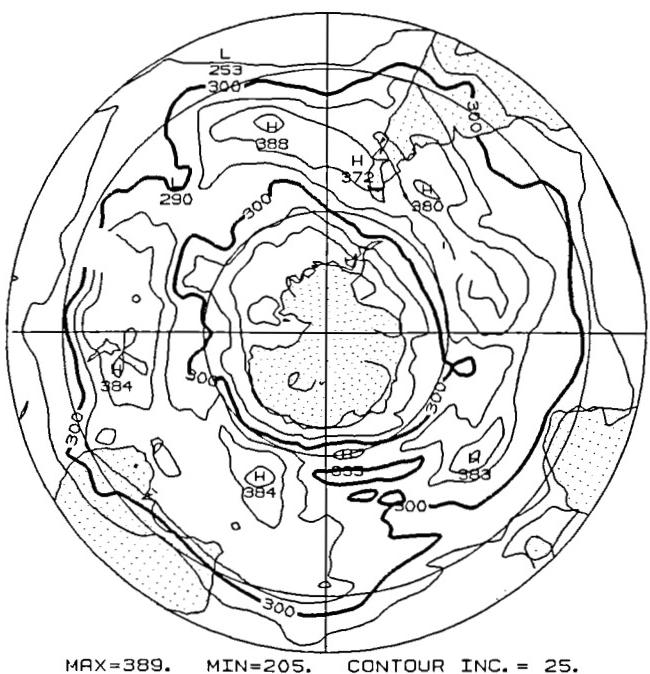


NMC 200-100 THICK. T O 8/28/87



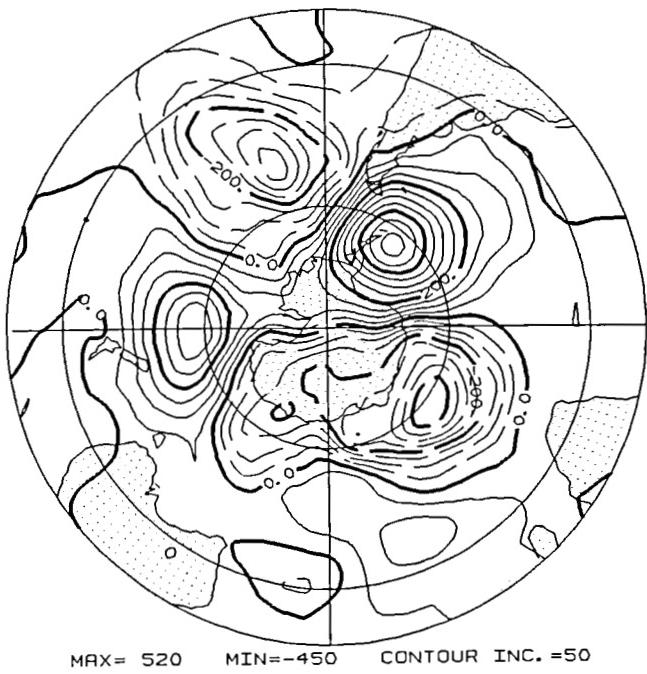
TOMS TOTAL OZONE

8/28/87



NMC 100MB HGT DEV.

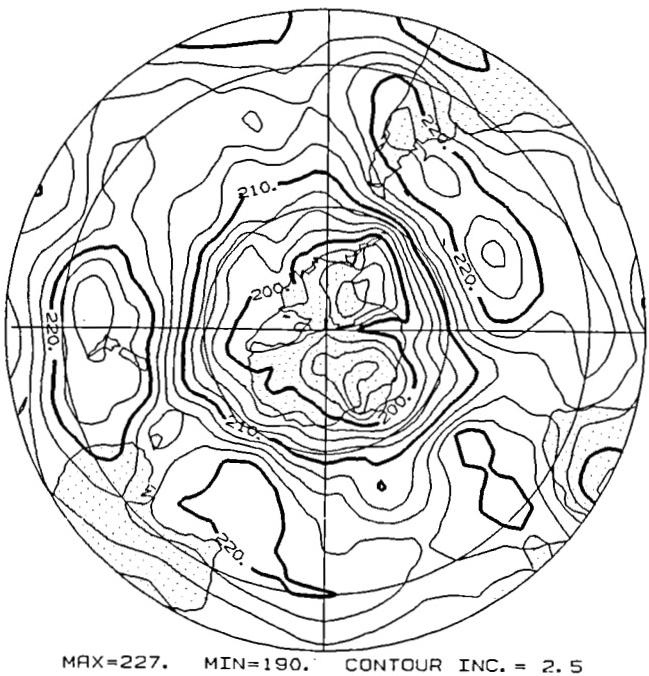
8/28/87



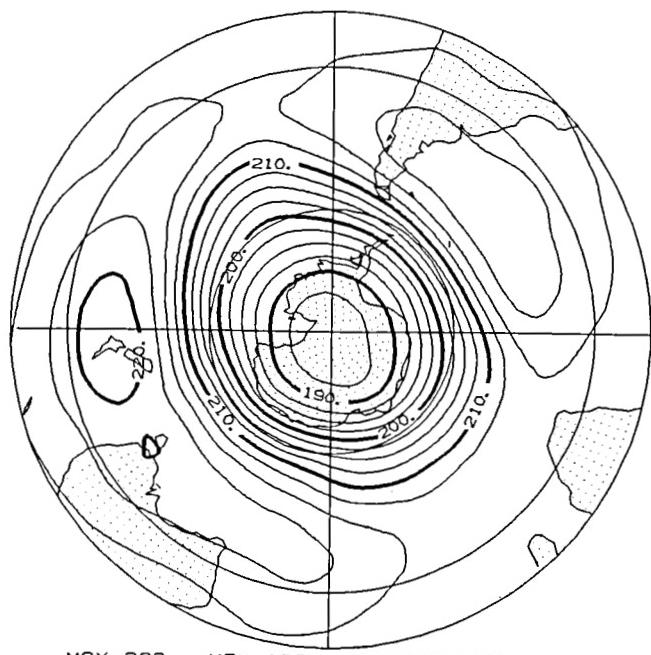
NMC 420K ERTEL POT VOR 8/28/87



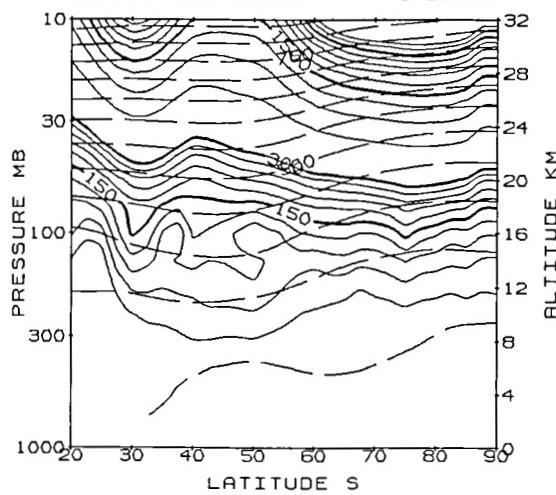
GLA 200-100 THICK. T 0 8/28/87



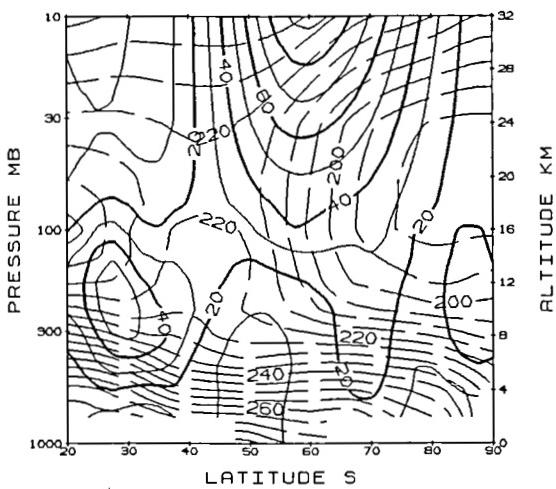
NMC 50-30MB THICKNESS 8/28/87



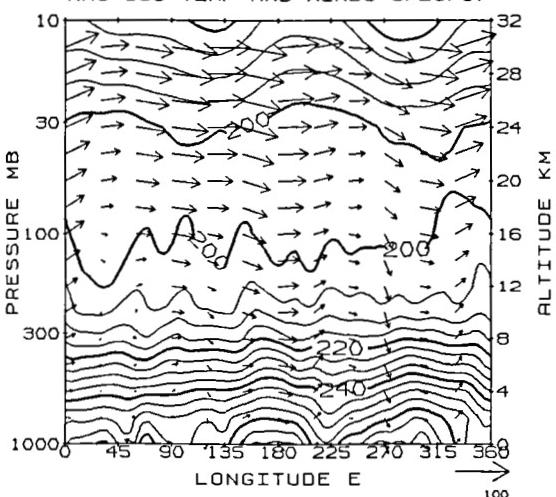
NMC PV AND THETA 8/28/87



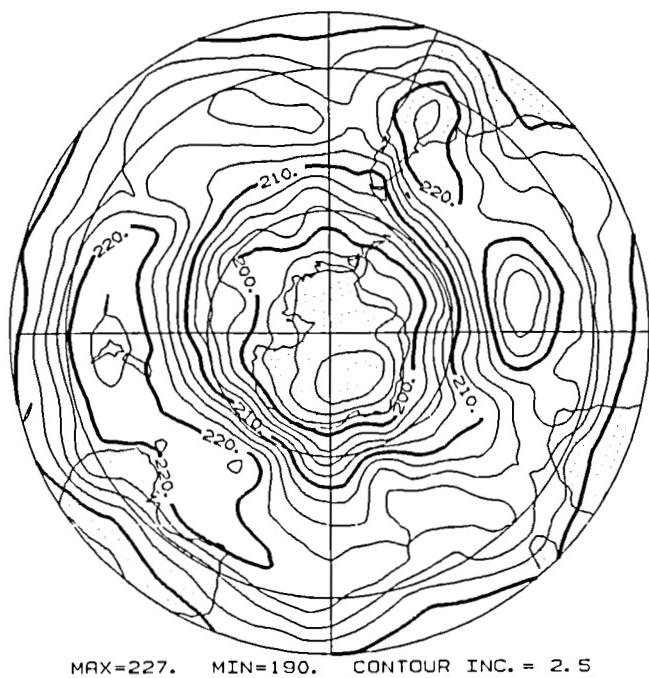
NMC 65W V (M/S) T (K) 8/28/87



NMC 65S TEMP AND WINDS 8/28/87

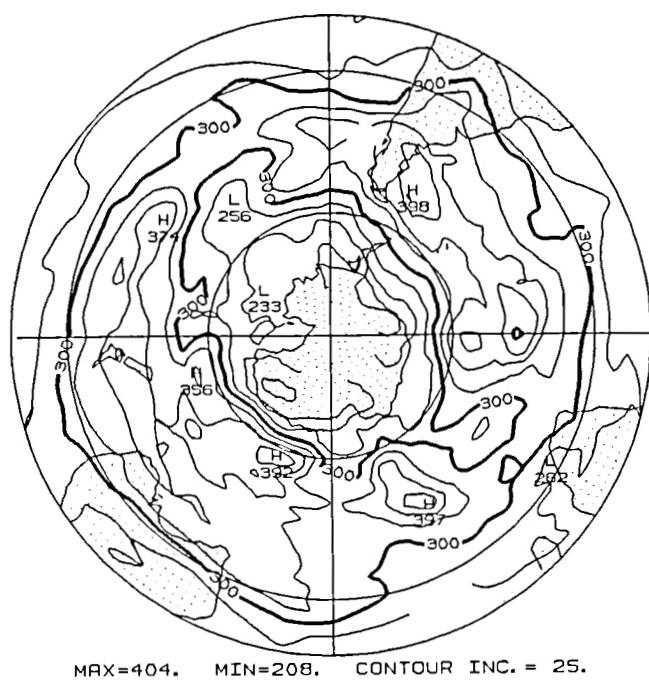


NMC 200-100 THICK. T 0 8/29/87



TOMS TOTAL OZONE

8/29/87

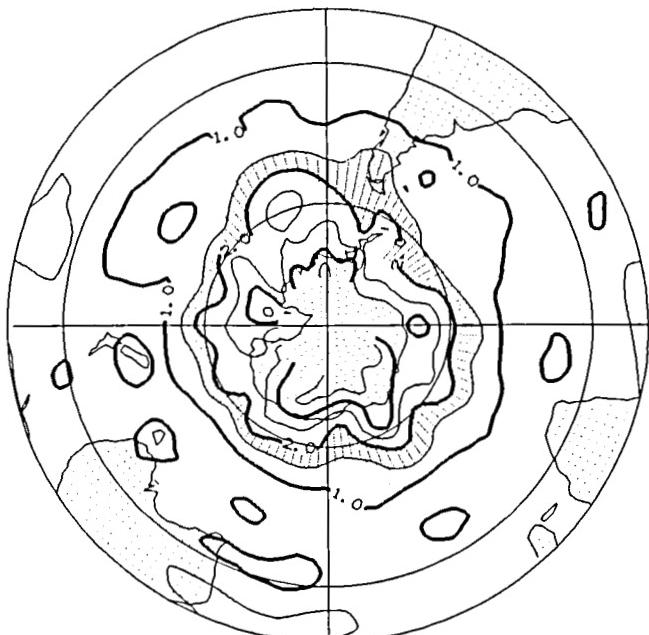


NMC 100MB HGT DEV.

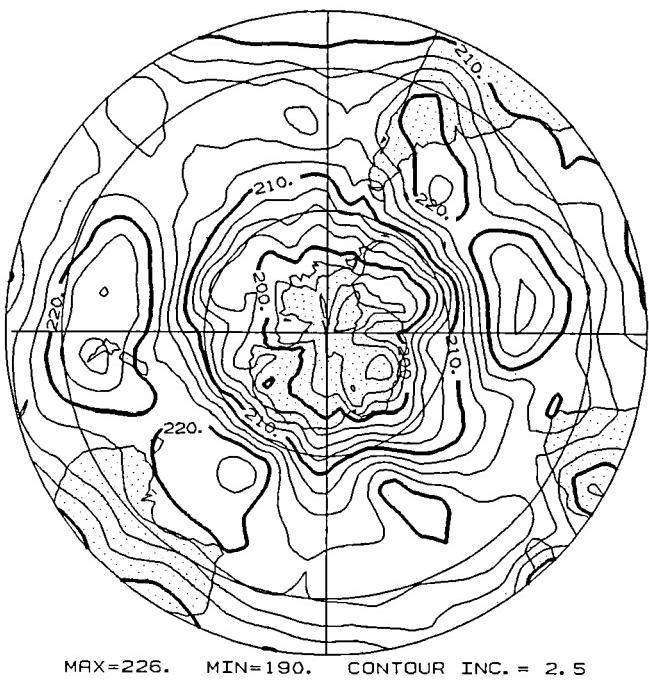
8/29/87



NMC 420K ERTEL POT VOR 8/29/87

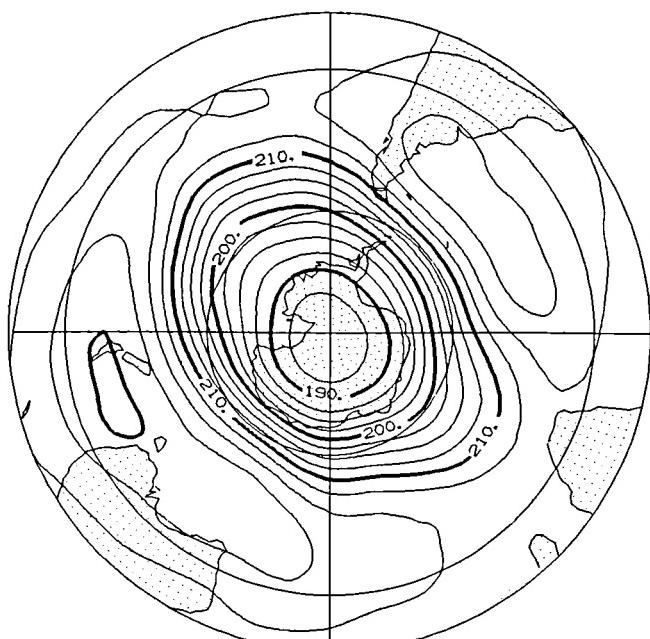


GLA 200-100 THICK. T 0 8/29/87

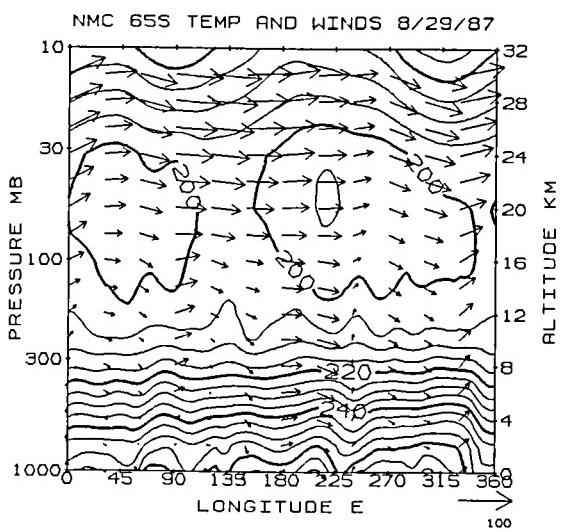
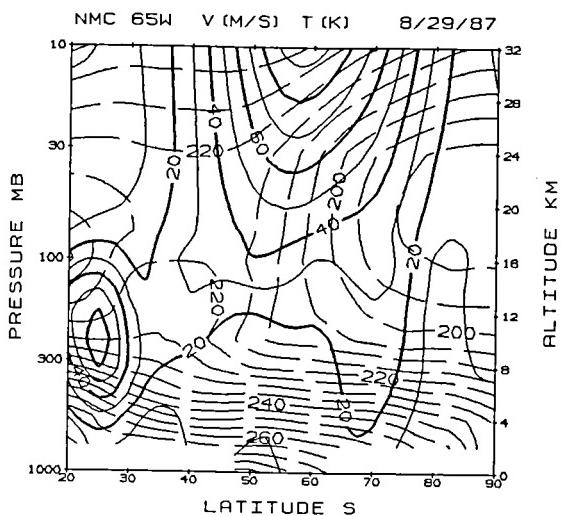
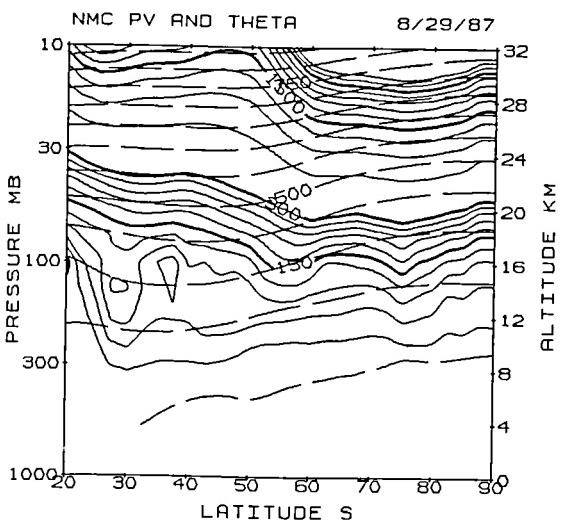


MAX=226. MIN=190. CONTOUR INC. = 2.5

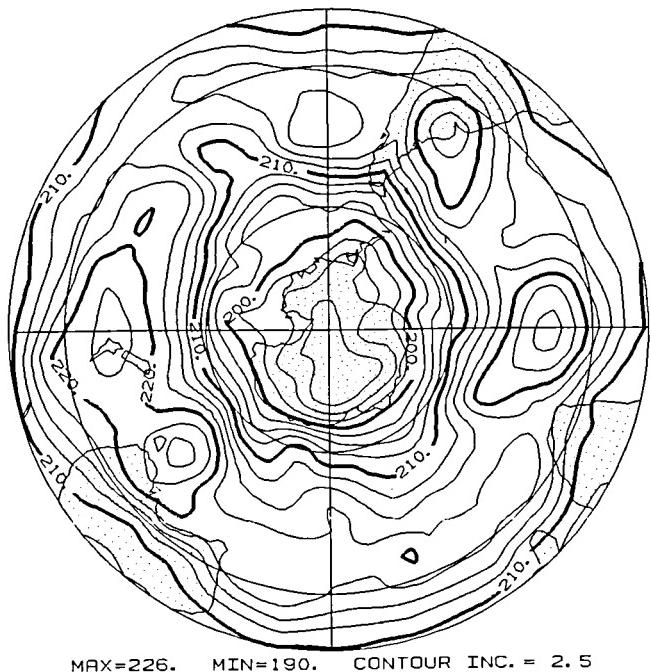
NMC 50-30MB THICKNESS 8/29/87



MAX=220. MIN=186. CONTOUR INC. = 2.5



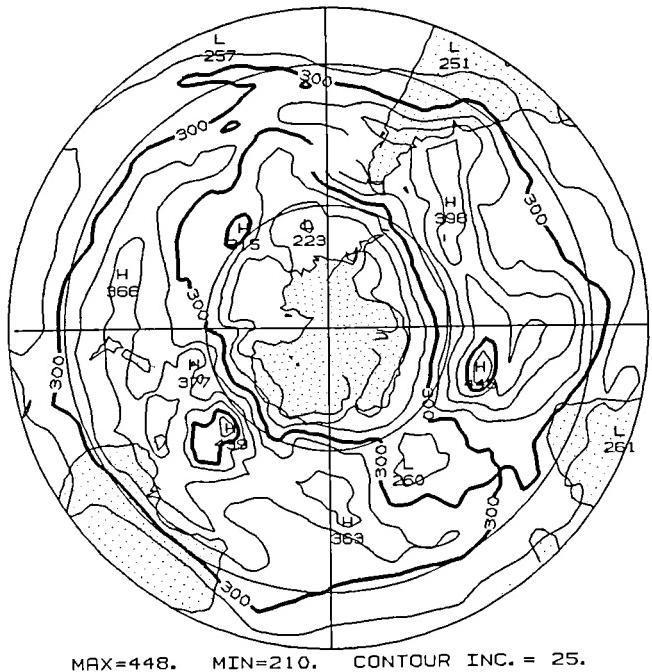
NMC 200-100 THICK. T 0 8/30/87



MAX=226. MIN=190. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

8/30/87



MAX=448. MIN=210. CONTOUR INC. = 25.

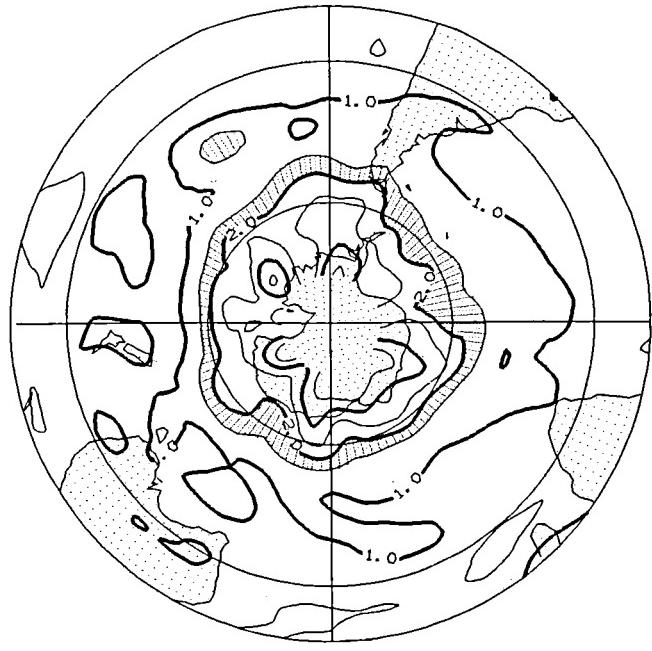
NMC 100MB HGT DEV.

8/30/87

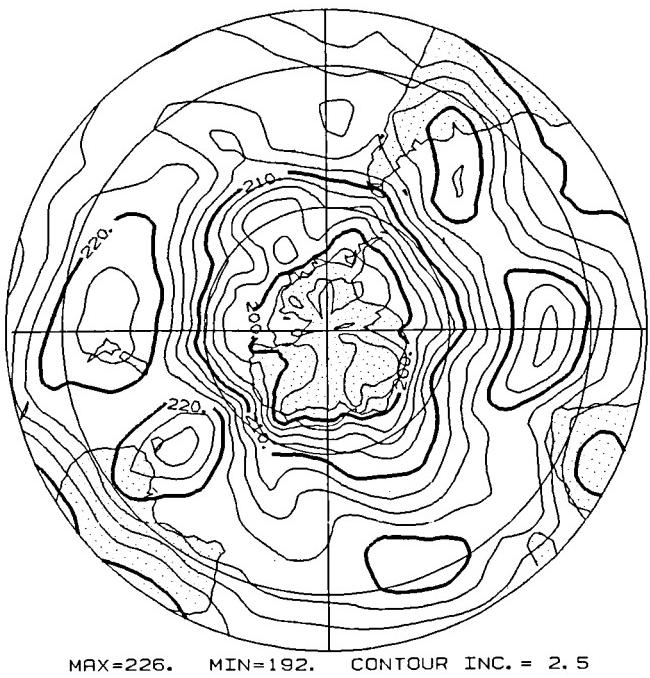


MAX= 313 MIN=-300 CONTOUR INC.=50

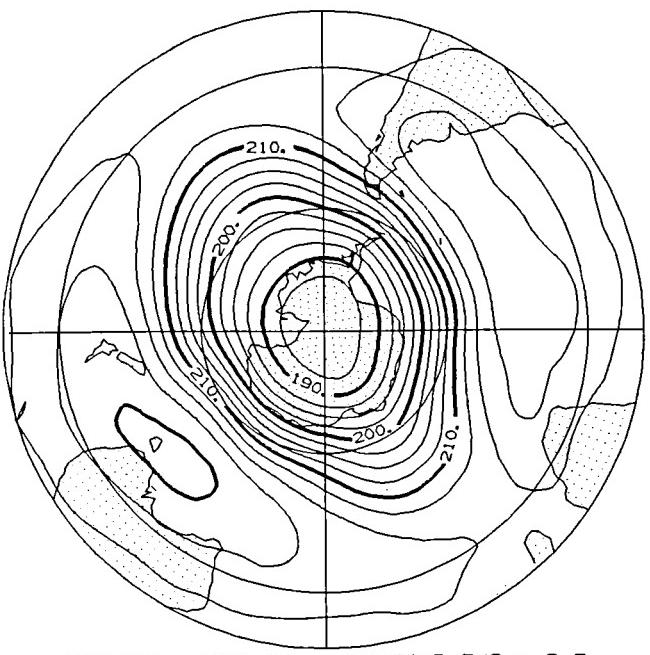
NMC 420K ERTEL POT VOR 8/30/87



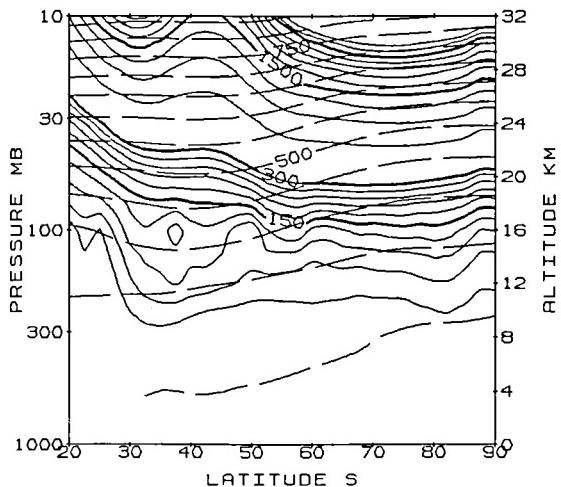
GLA 200-100 THICK. T 0 8/30/87



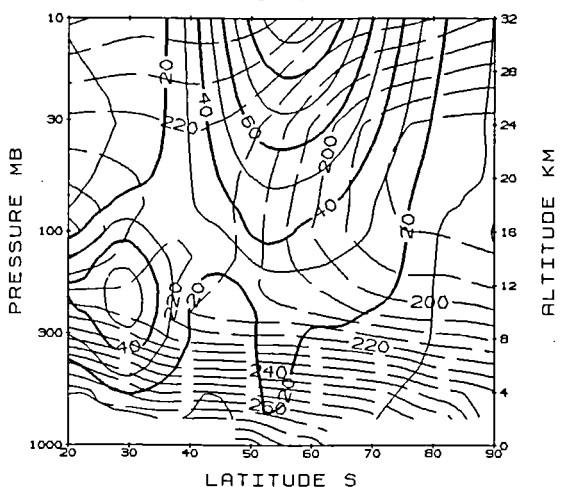
NMC 50-30MB THICKNESS 8/30/87



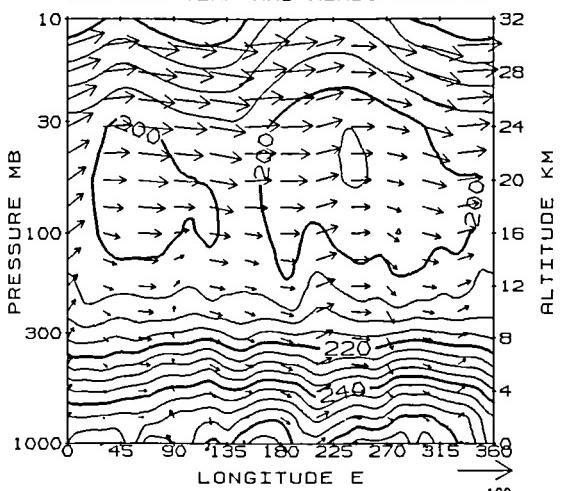
NMC PV AND THETA 8/30/87



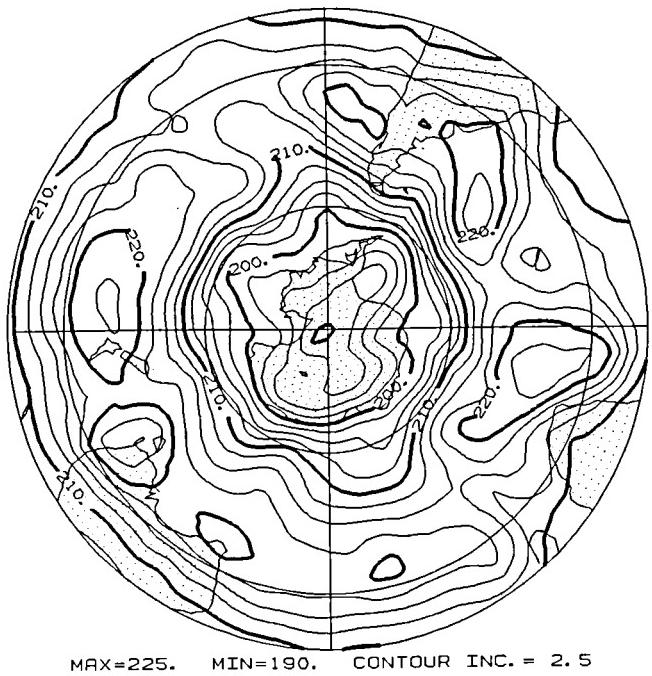
NMC 65W V (M/S) T (K) 8/30/87



NMC 65S TEMP AND WINDS 8/30/87

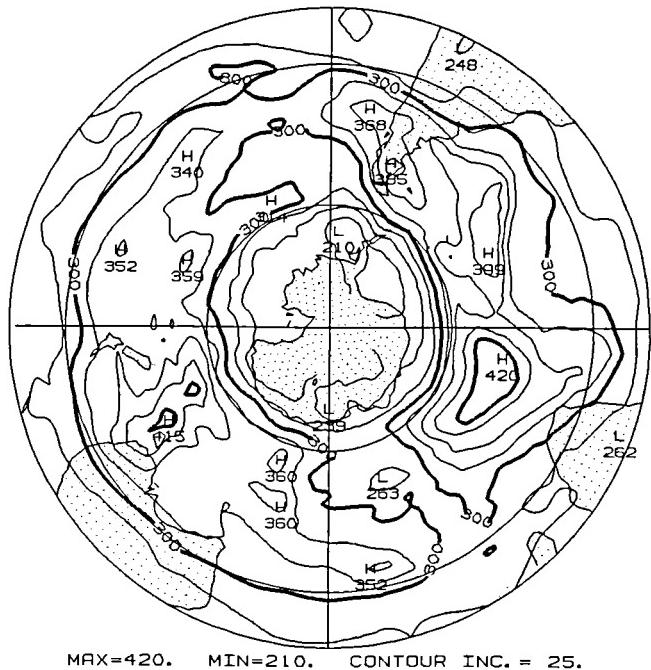


NMC 200-100 THICK. T O 8/31/87



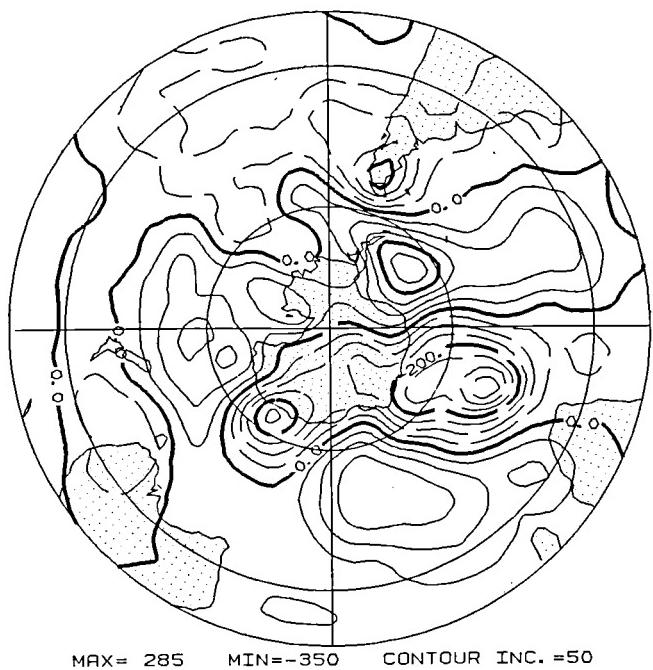
TOMS TOTAL OZONE

8/31/87

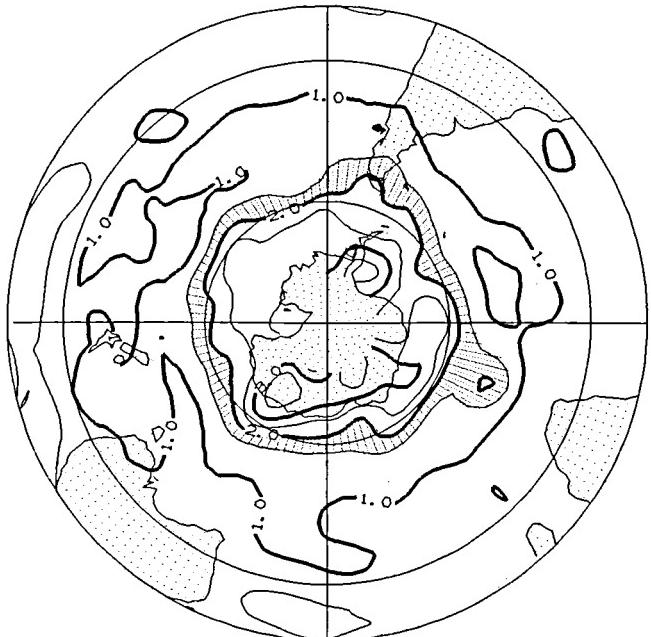


NMC 100MB HGT DEV.

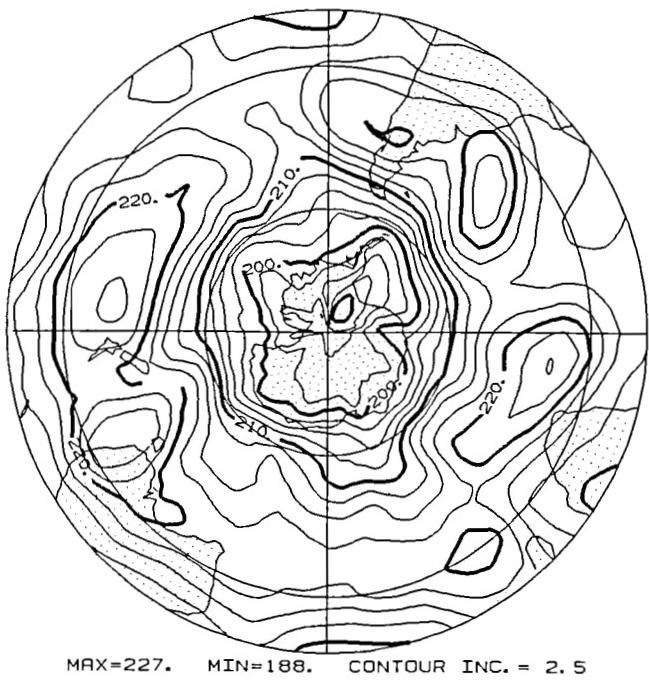
8/31/87



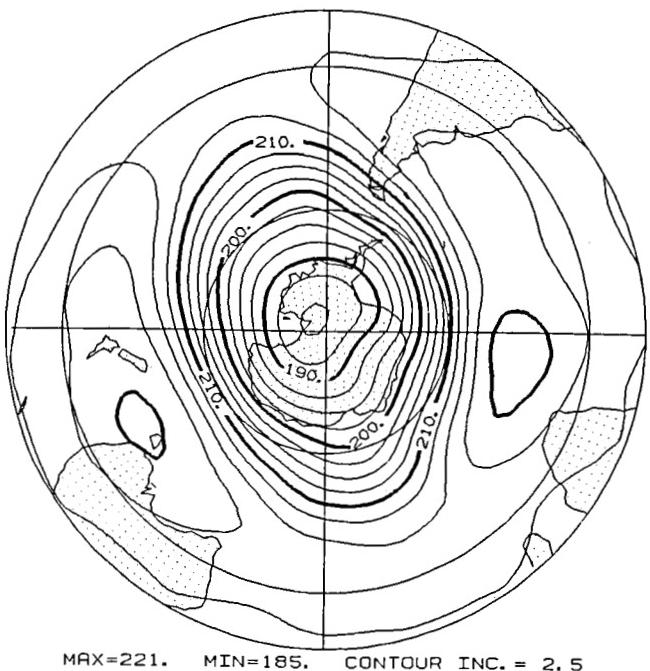
NMC 420K ERTEL POT VOR 8/31/87



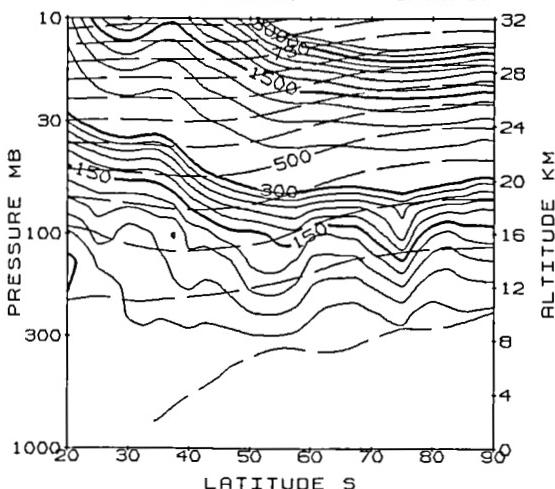
GLA 200-100 THICK. T 0 8/31/87



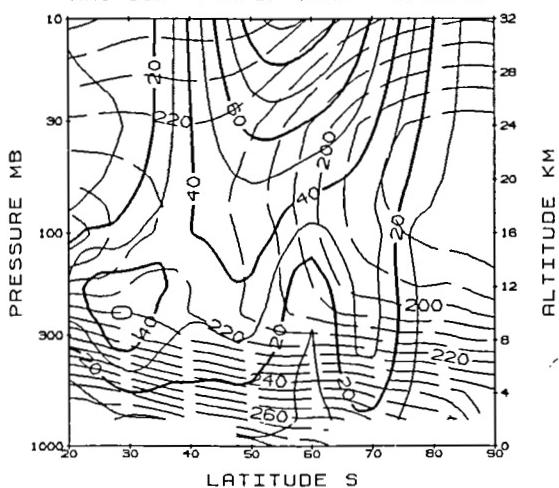
NMC 50-30MB THICKNESS 8/31/87



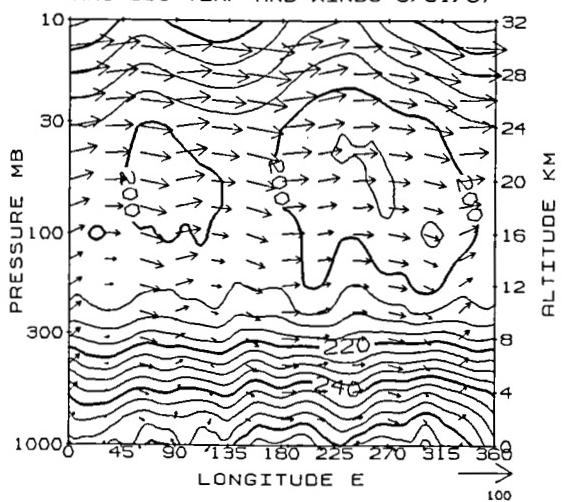
NMC PV AND THETA 8/31/87



NMC 65W V (M/S) T (K) 8/31/87



NMC 65S TEMP AND WINDS 8/31/87

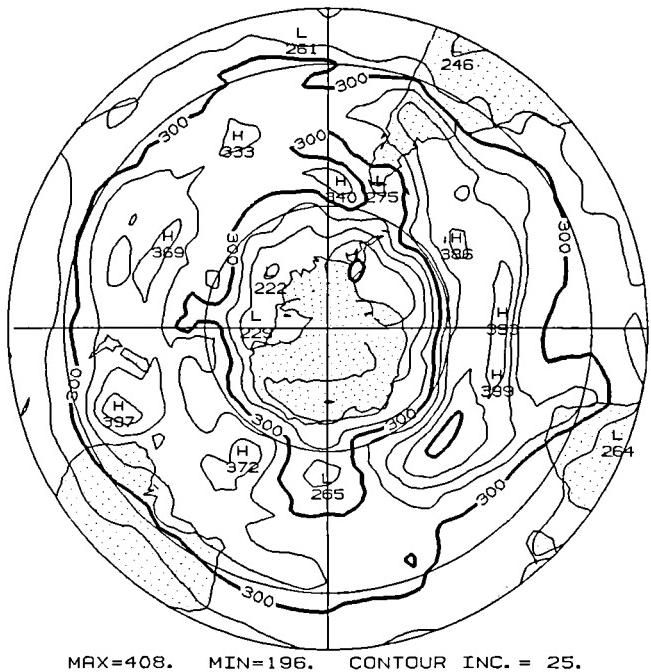


NMC 200-100 THICK. T O 9/ 1/87

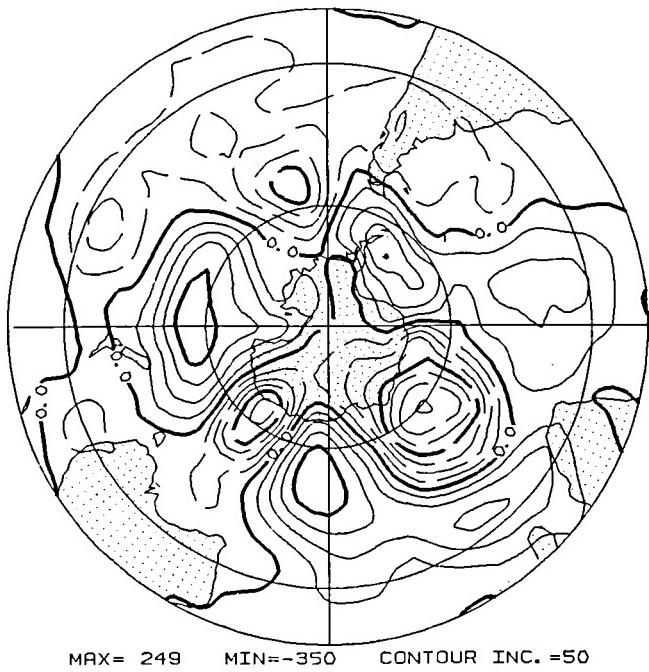


## TOMS TOTAL OZONE

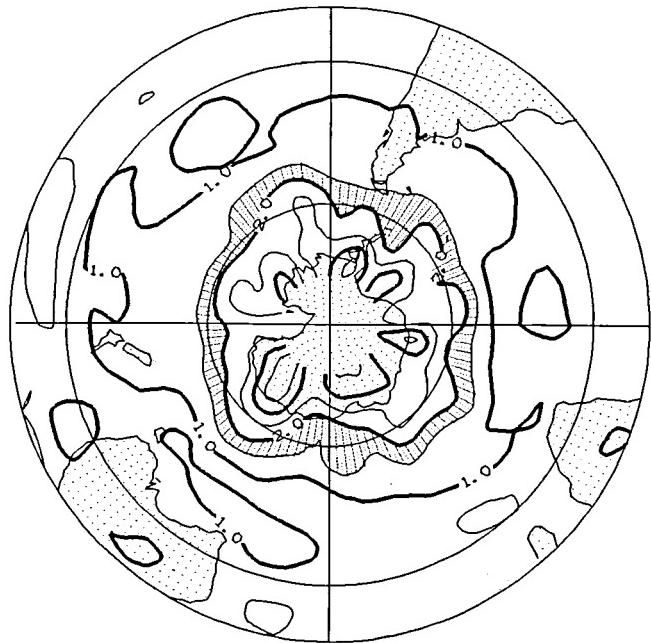
9/ 1/87



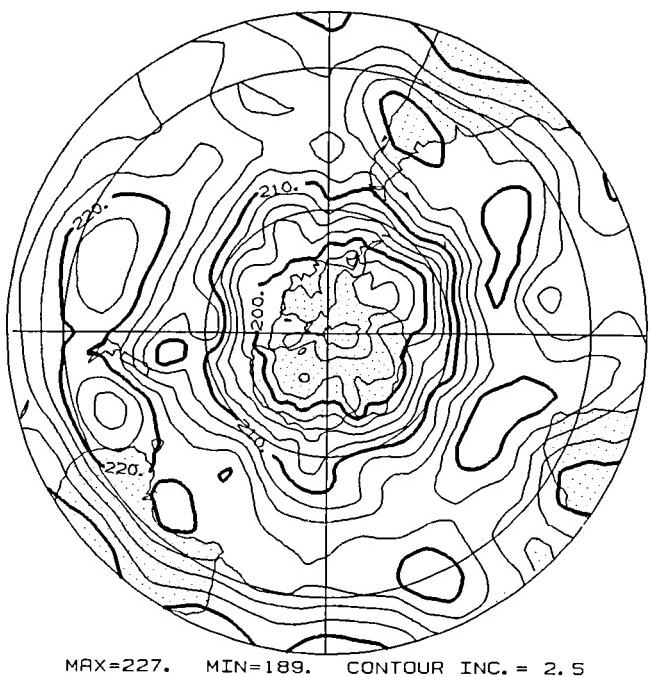
NMC 100MB HGT DEV. 9/ 1/87



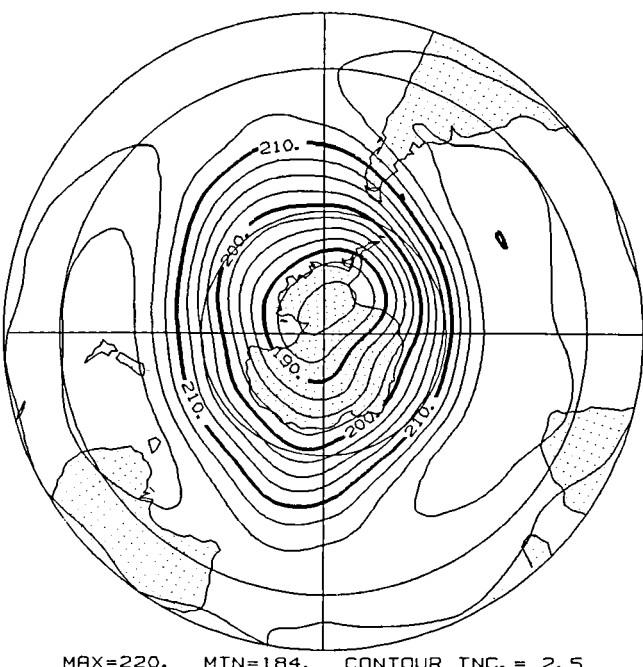
NMC 420K ERTEL POT VOR 9/ 1/87



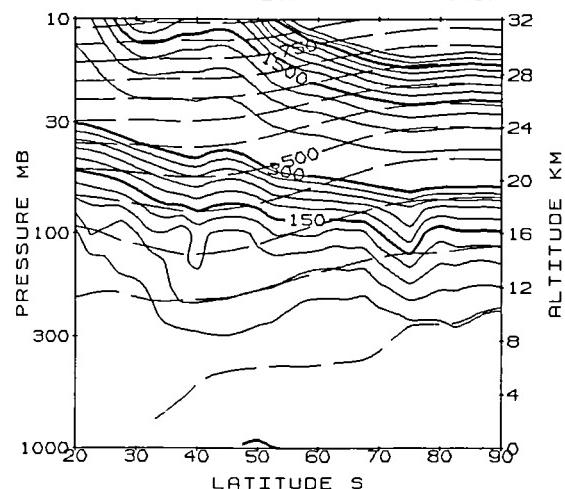
GLA 200-100 THICK. T 0 9/ 1/87



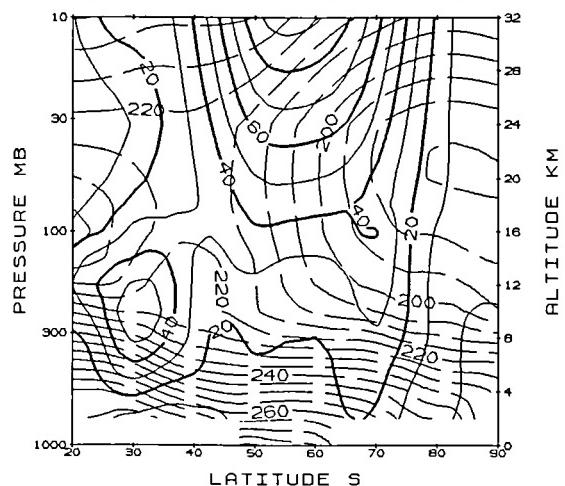
NMC 50-30MB THICKNESS 9/ 1/87



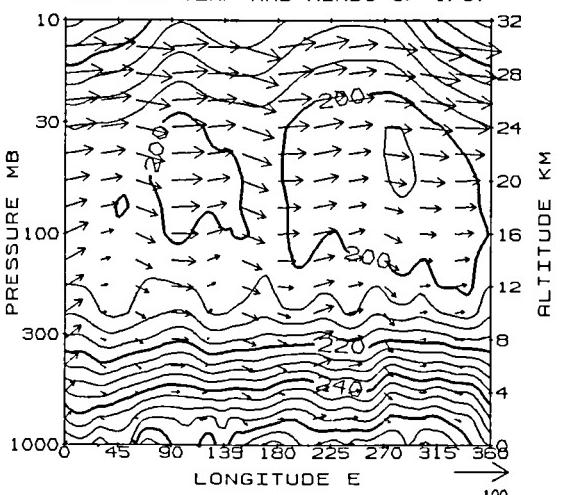
NMC PV AND THETA 9/ 1/87



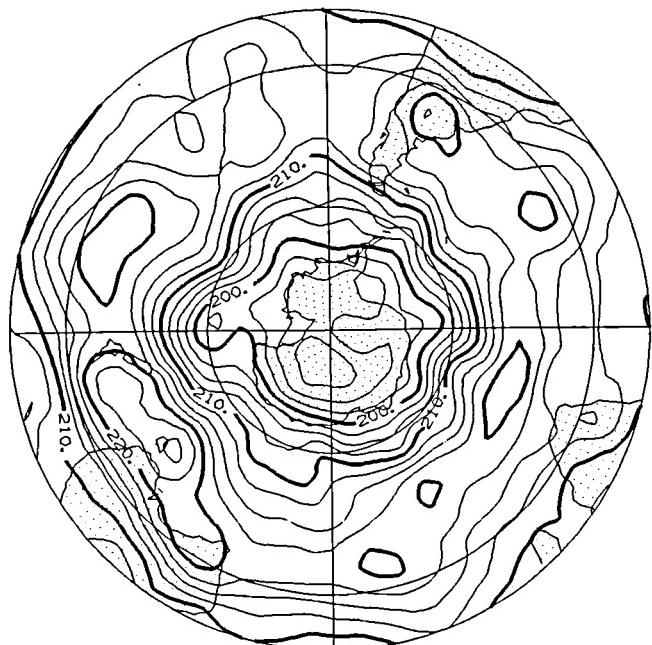
NMC 65W V (M/S) T (K) 9/ 1/87



NMC 65S TEMP AND WINDS 9/ 1/87



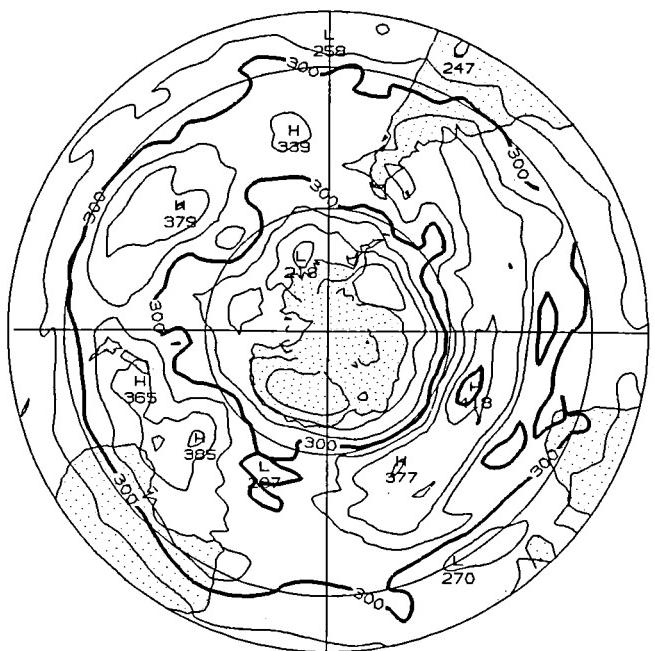
NMC 200-100 THICK. T 0 9/ 2/87



MAX=225. MIN=191. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

9/ 2/87



MAX=418. MIN=204. CONTOUR INC. = 25.

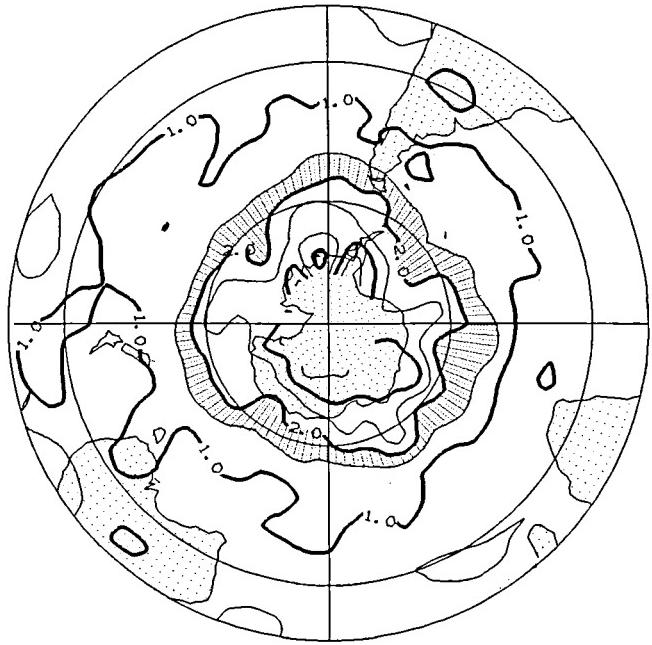
NMC 100MB HGT DEV.

9/ 2/87

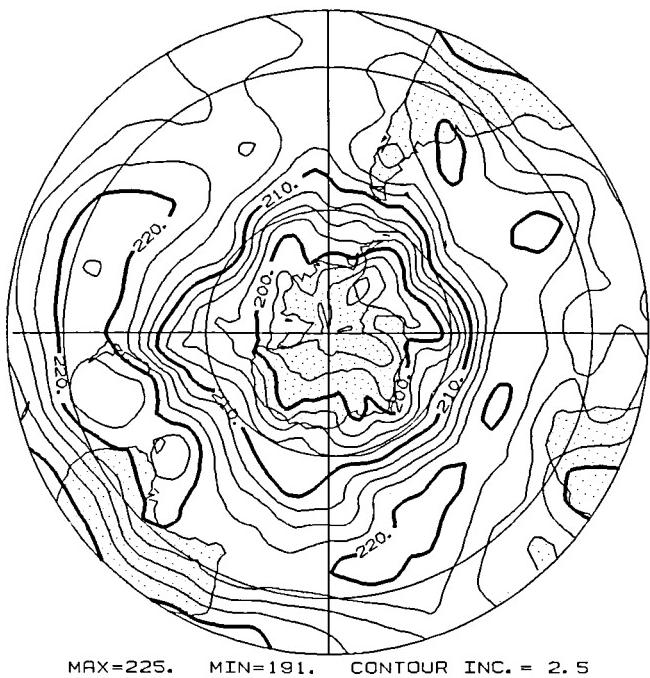


MAX= 290 MIN=-350 CONTOUR INC. =50

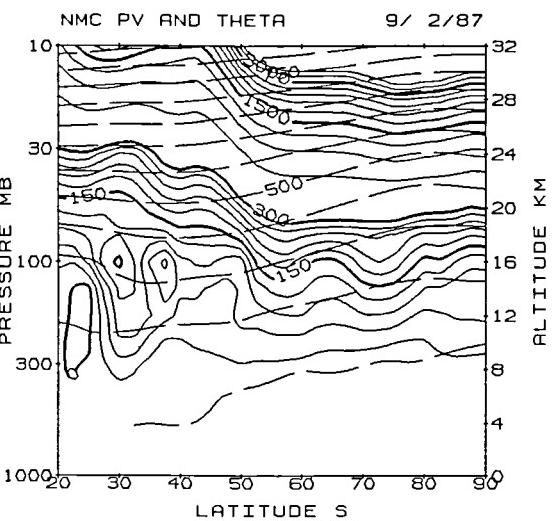
NMC 420K ERTEL POT VOR 9/ 2/87



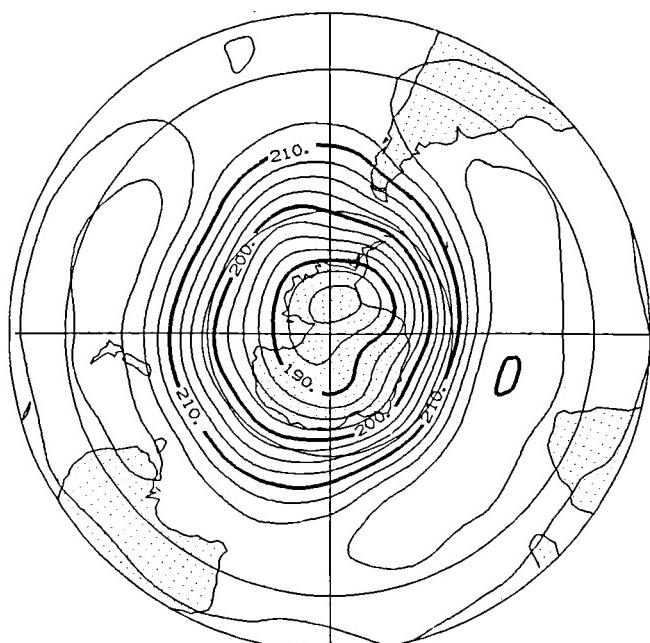
GLA 200-100 THICK. T 0 9/ 2/87



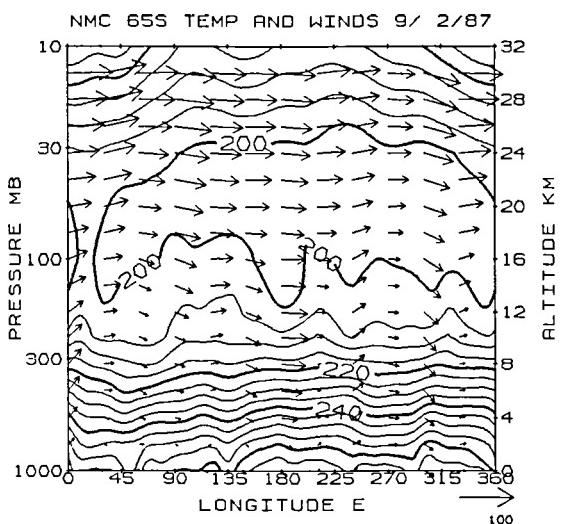
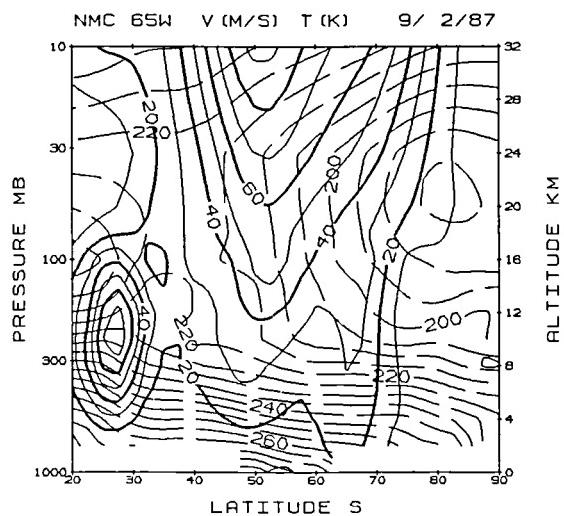
MAX=225. MIN=191. CONTOUR INC. = 2.5



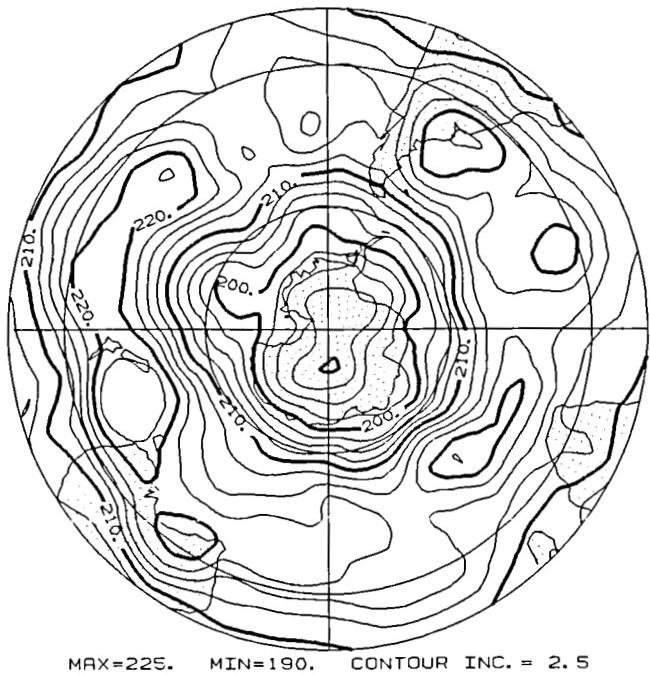
NMC 50-30MB THICKNESS 9/ 2/87



MAX=220. MIN=184. CONTOUR INC. = 2.5

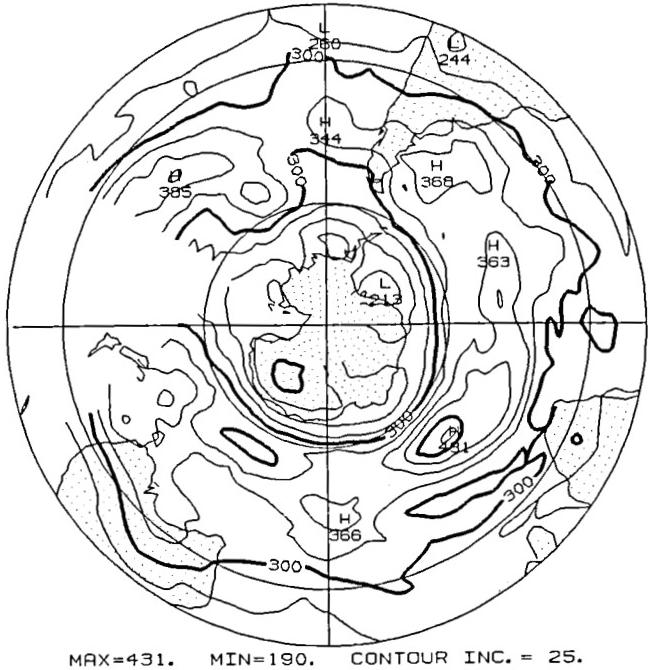


NMC 200-100 THICK. T 0 9/ 3/87



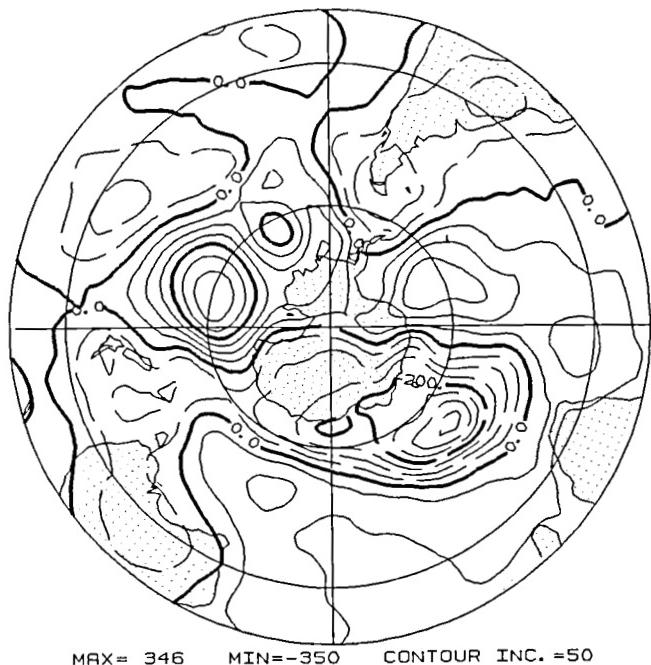
TOMS TOTAL OZONE

9/ 3/87

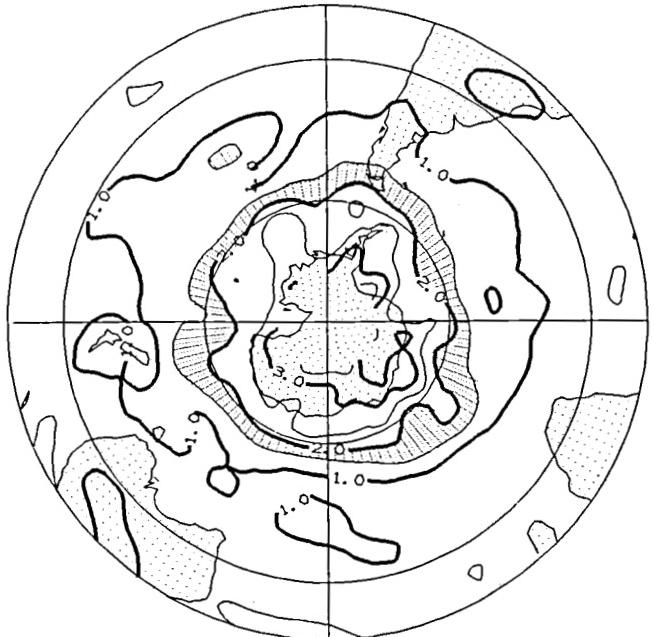


NMC 100MB HGT DEV.

9/ 3/87



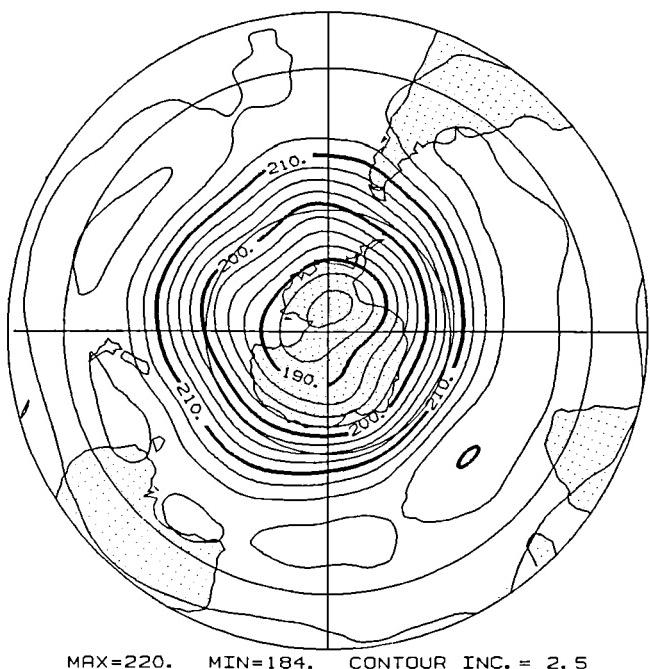
NMC 420K ERTEL POT VOR 9/ 3/87



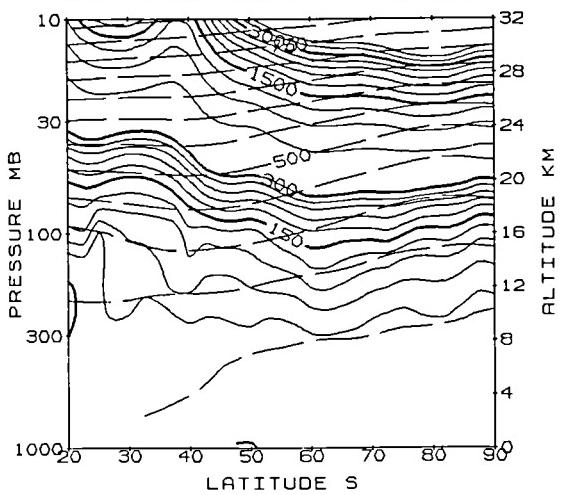
GLA 200-100 THICK. T 0 9/ 3/87



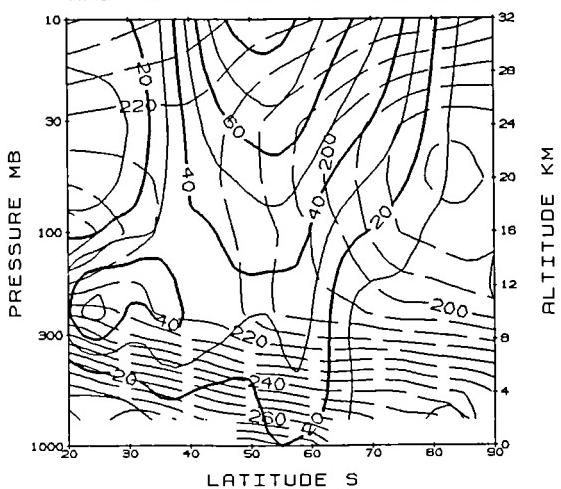
NMC 50-30MB THICKNESS 9/ 3/87



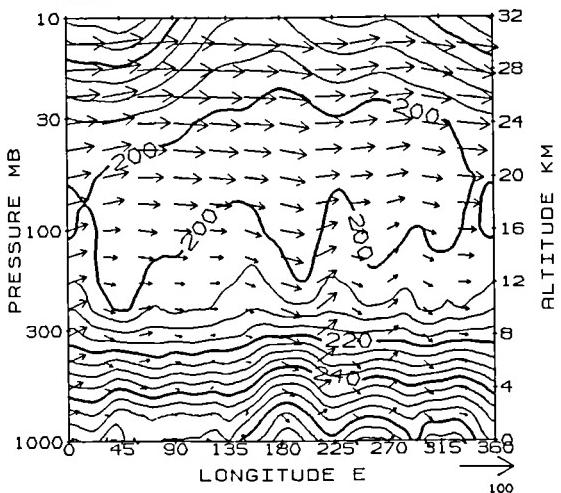
NMC PV AND THETA 9/ 3/87



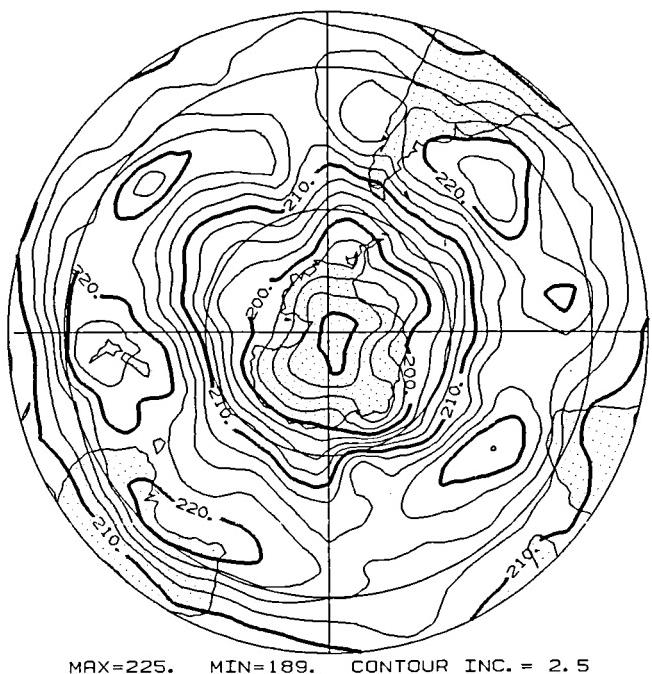
NMC 65W V (M/S) T (K) 9/ 3/87



NMC 65S TEMP AND WINDS 9/ 3/87



NMC 200-100 THICK. T 0 9/ 4/87



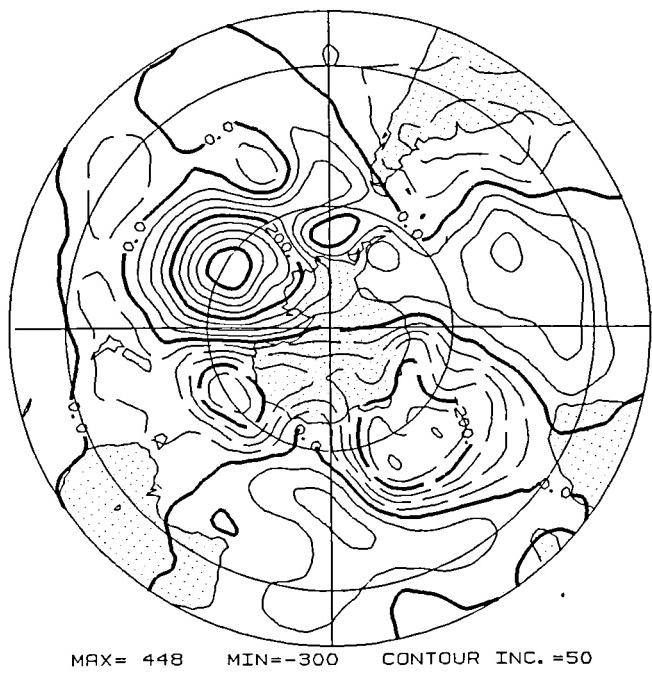
TOMS TOTAL OZONE

9/ 4/87

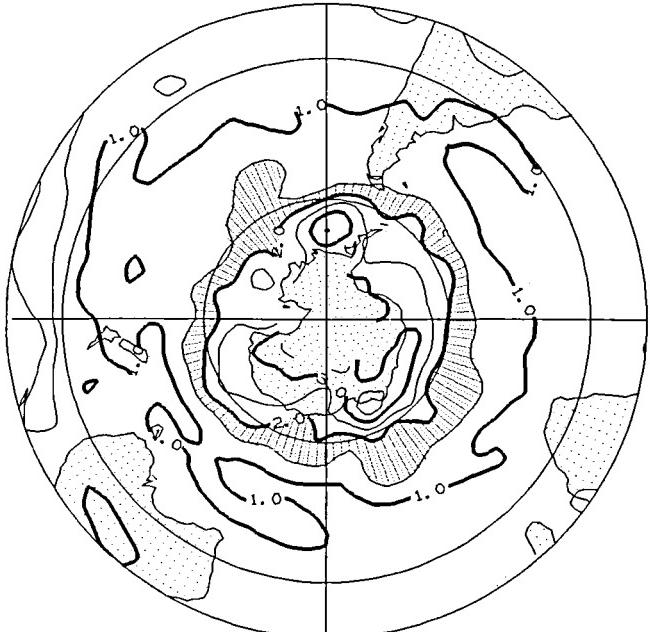


NMC 100MB HGT DEV.

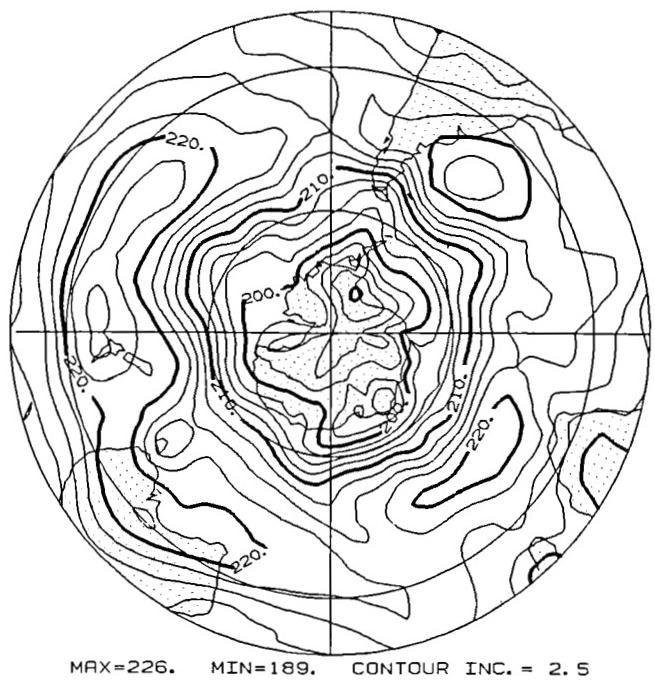
9/ 4/87



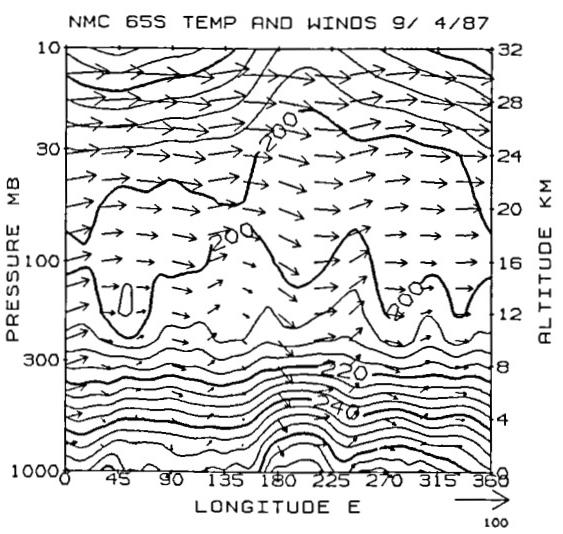
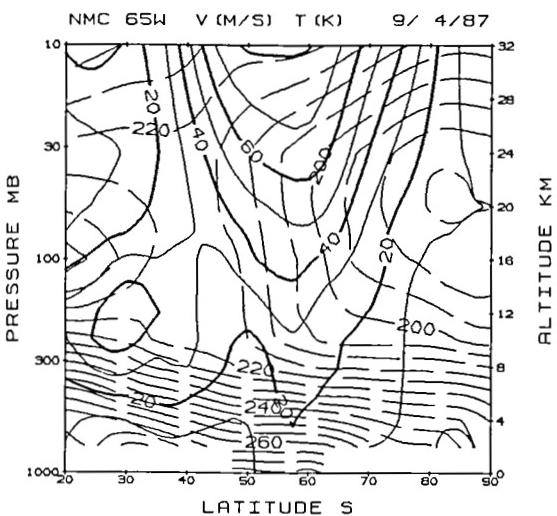
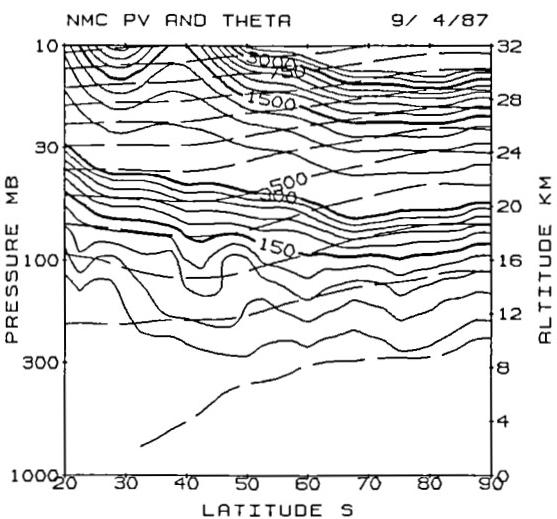
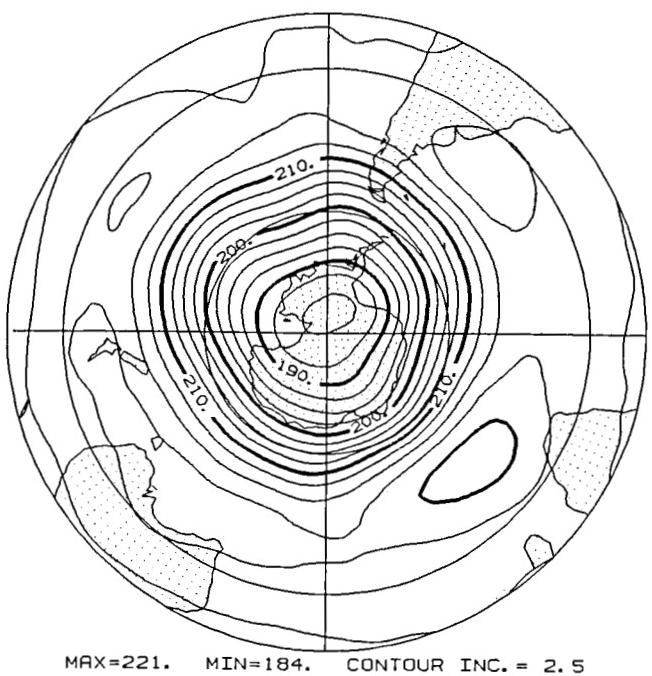
NMC 420K ERTEL POT VOR 9/ 4/87



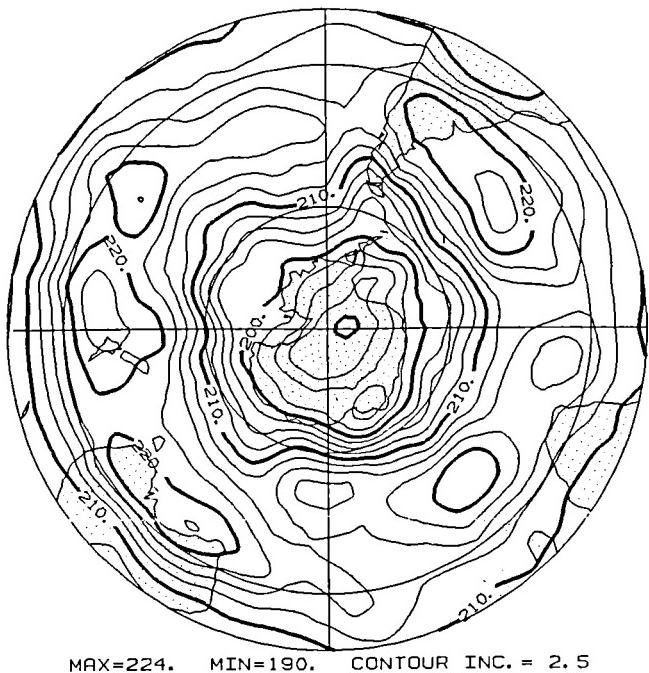
GLA 200-100 THICK. T O 9/ 4/87



NMC 50-30MB THICKNESS 9/ 4/87

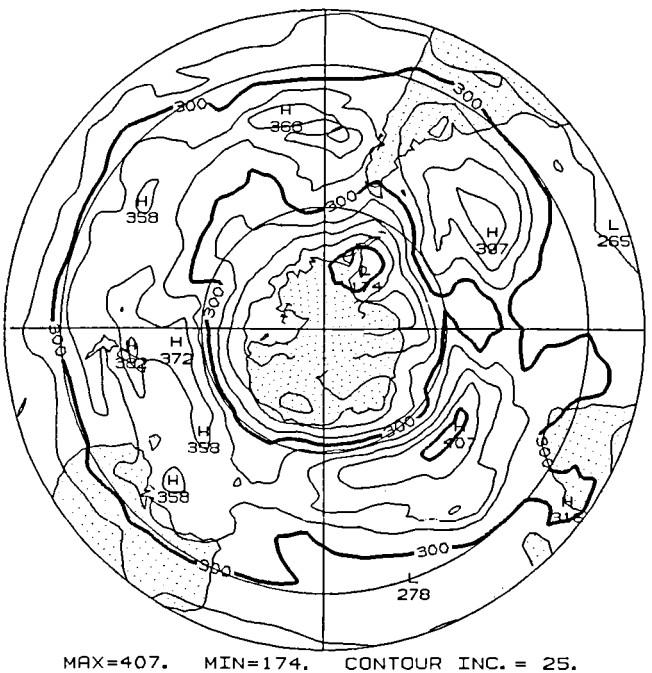


NMC 200-100 THICK. T O 9/ 5/87



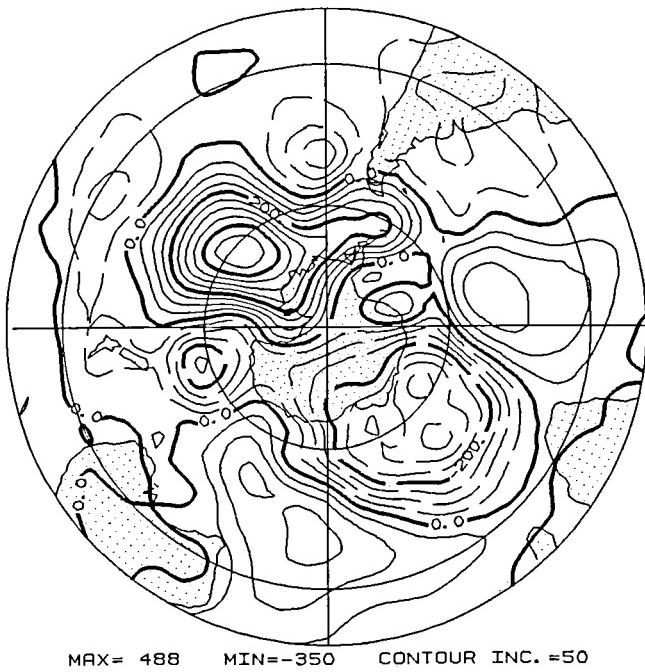
## TOMS TOTAL OZONE

9/ 5/87



NMC 100MB HGT DEV.

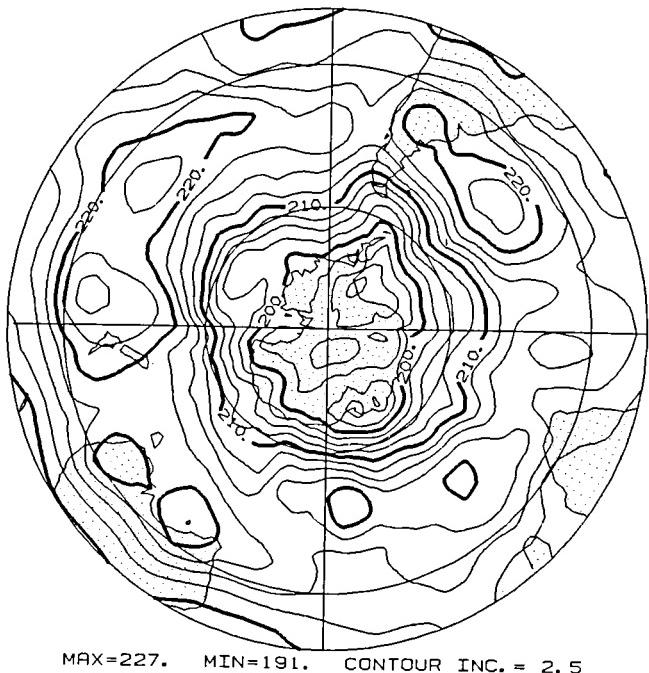
9 / 5 / 87



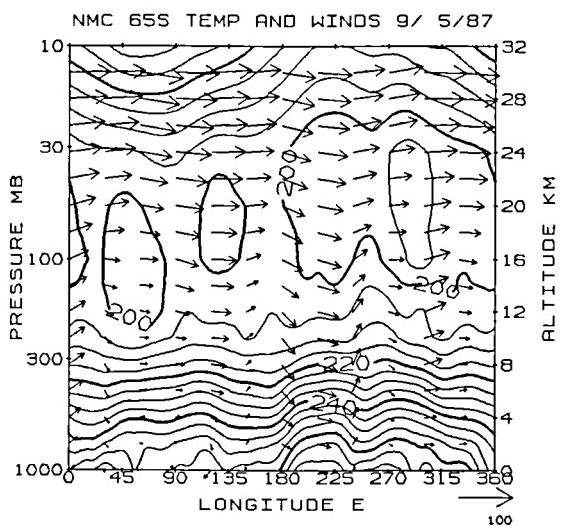
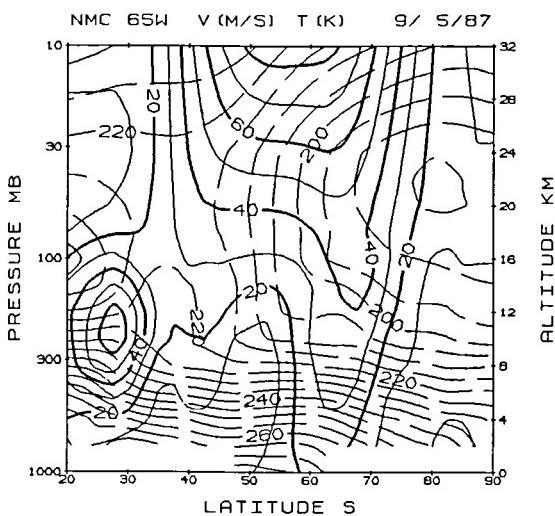
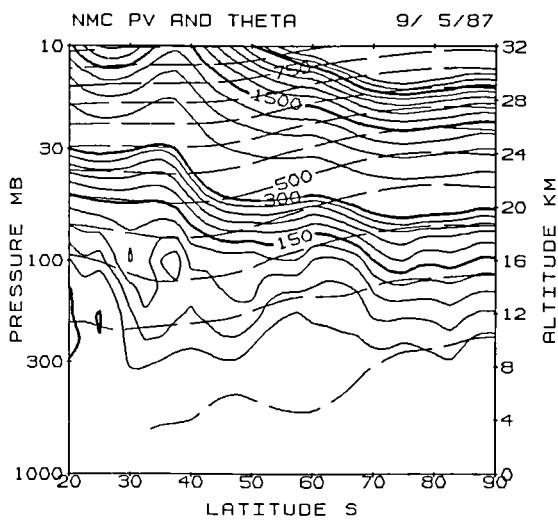
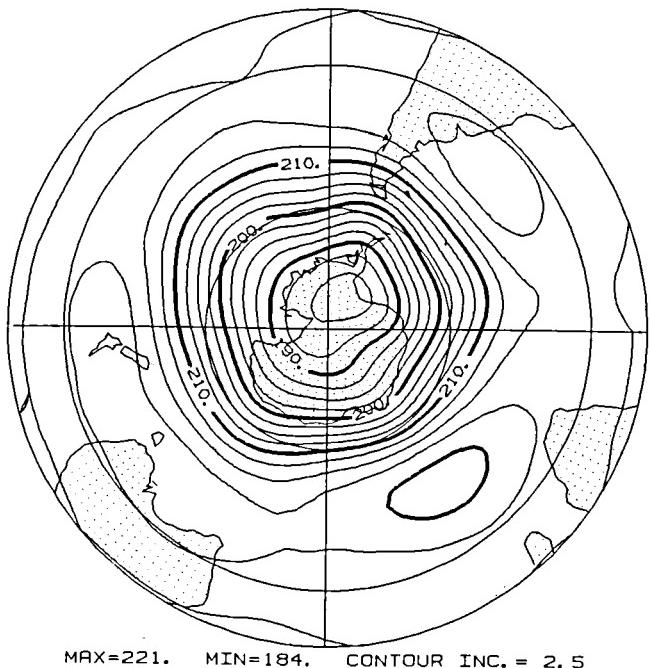
NMC 420K ERTEL POT VOR 9/ 5/87



GLA 200-100 THICK. T 0 9/ 5/87



NMC 50-30MB THICKNESS 9/ 5/87



NMC 200-100 THICK. T 0 9/ 6/87



MAX=224. MIN=190. CONTOUR INC. = 2.5

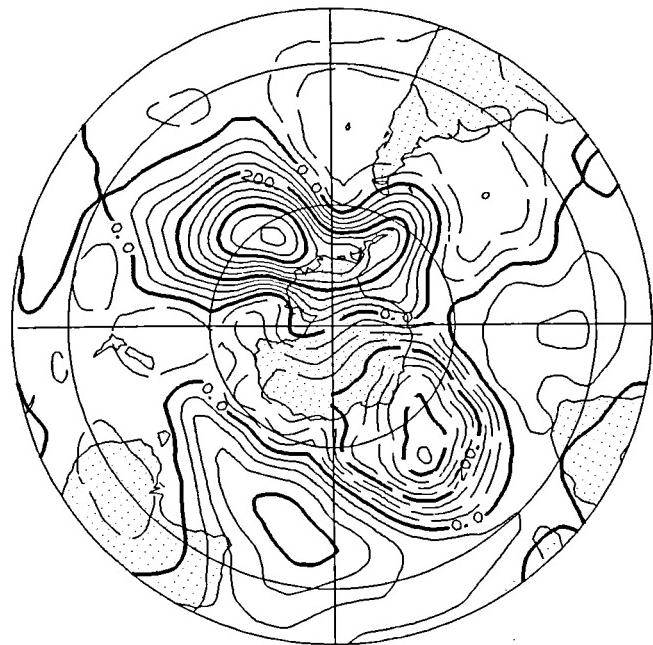
TOMS TOTAL OZONE

9/ 6/87



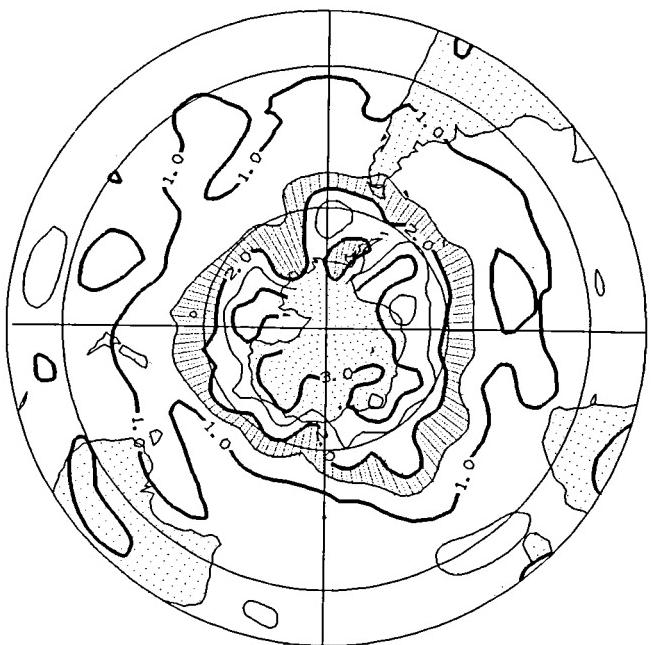
MAX=426. MIN=174. CONTOUR INC. = 25.

NMC 100MB HGT DEV. 9/ 6/87

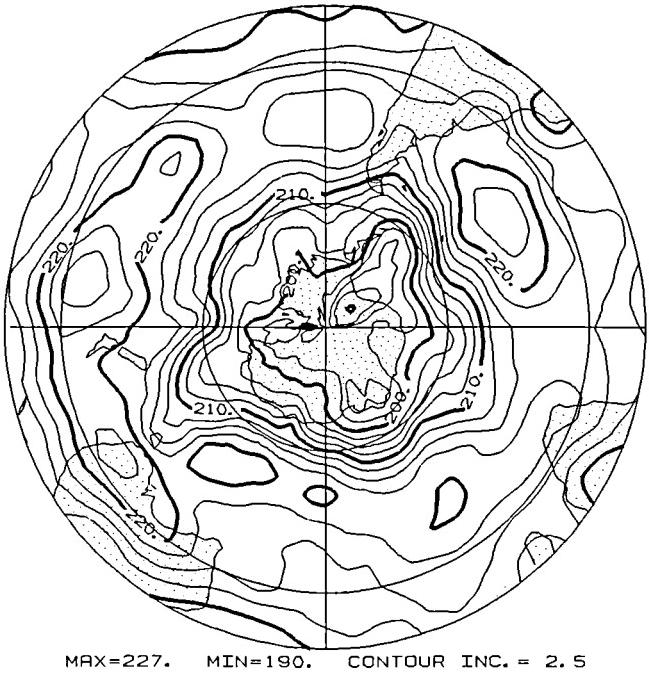


MAX= 514 MIN=-450 CONTOUR INC. =50

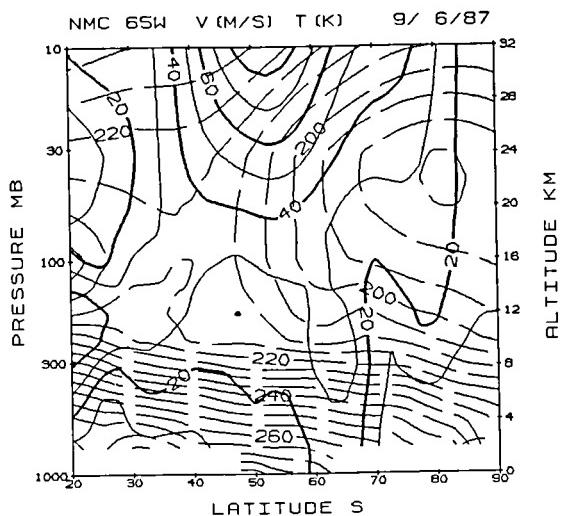
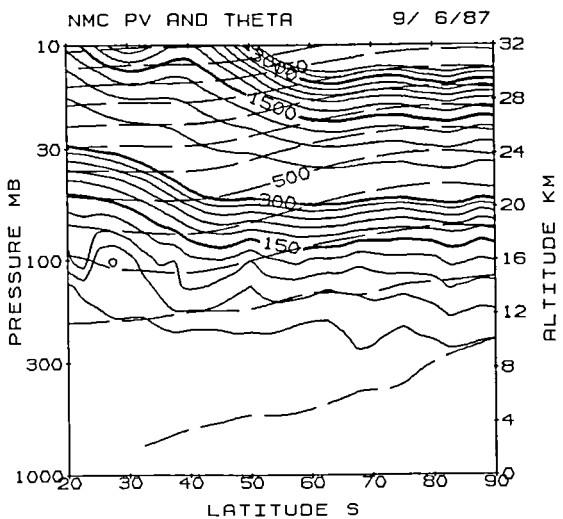
NMC 420K ERTEL POT VOR 9/ 6/87



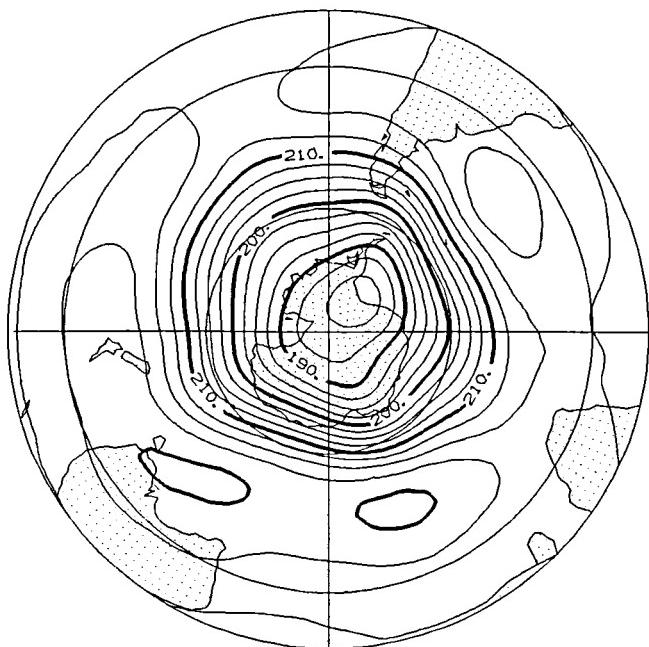
GLA 200-100 THICK. T 0 9/ 6/87



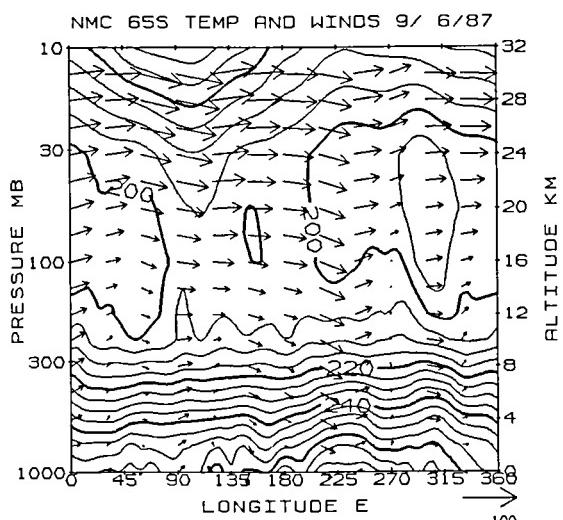
MAX=227. MIN=190. CONTOUR INC. = 2.5



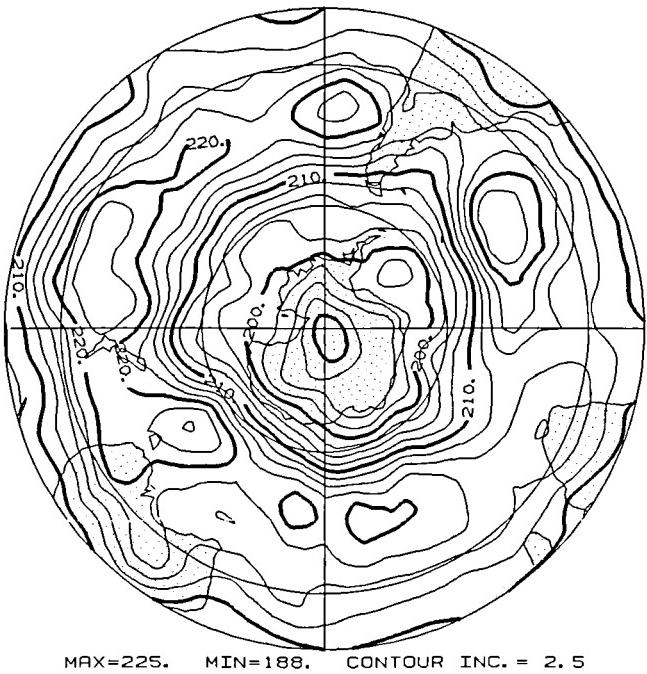
NMC 50-30MB THICKNESS 9/ 6/87



MAX=221. MIN=184. CONTOUR INC. = 2.5

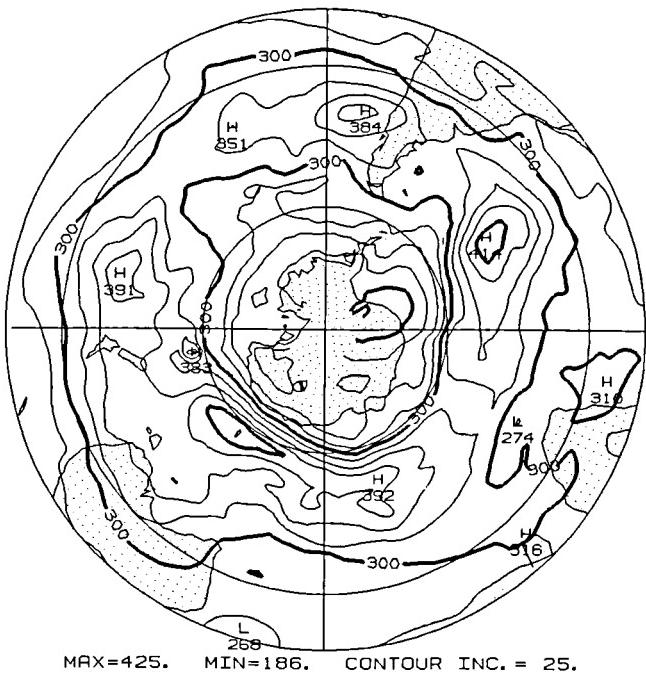


NMC 200-100 THICK. T 0 9/ 7/87



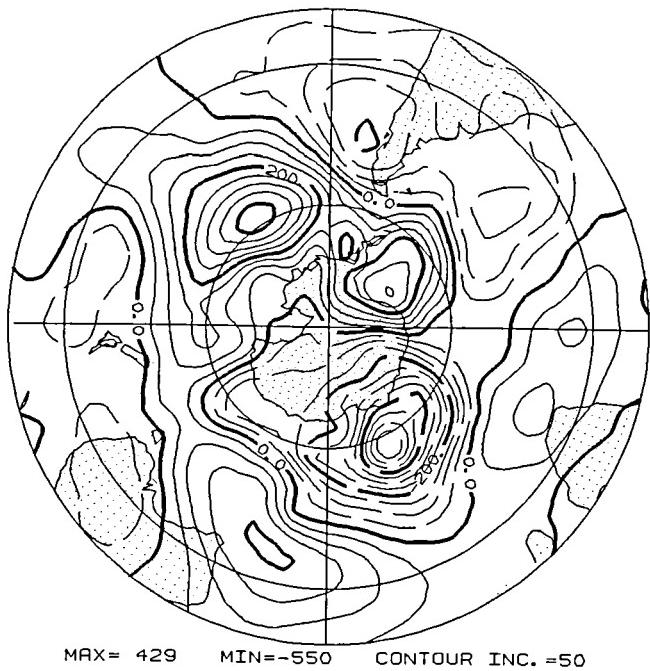
TOMS TOTAL OZONE

9/ 7/87



NMC 100MB HGT DEV.

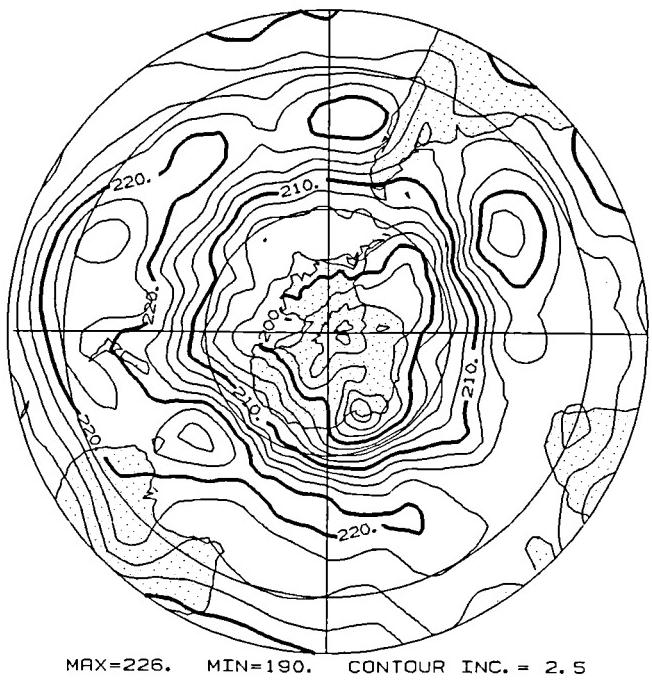
9/ 7/87



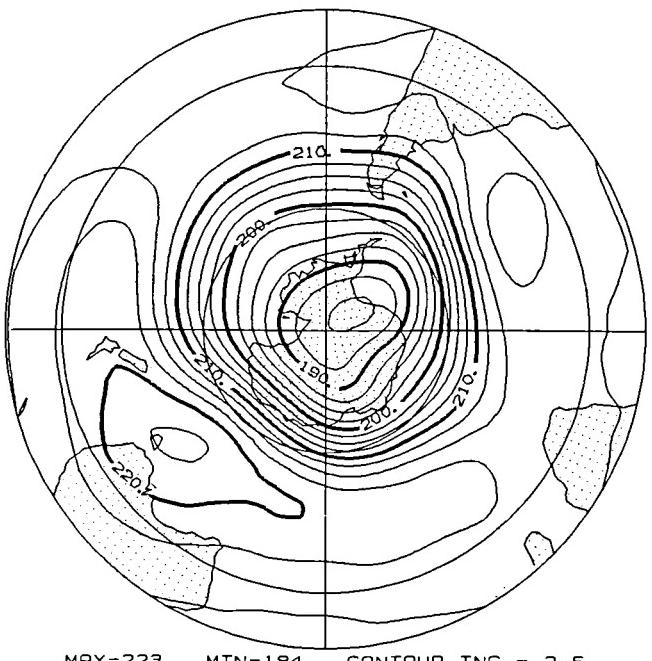
NMC 420K ERTEL POT VOR 9/ 7/87



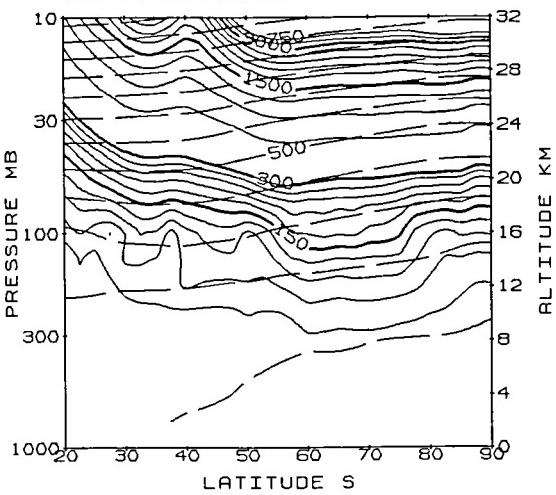
GLA 200-100 THICK. T O 9/ 7/87



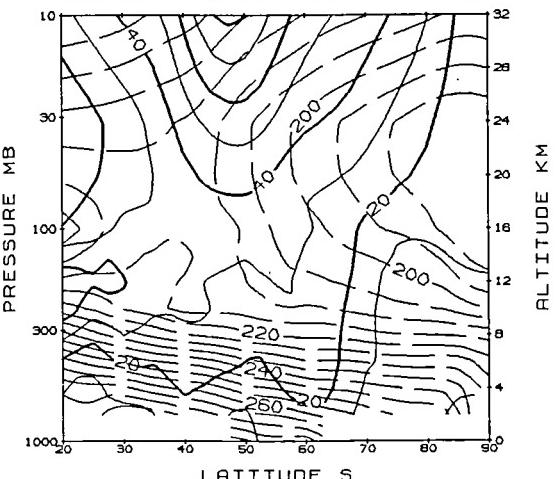
NMC 50-30MB THICKNESS 9/ 7/87



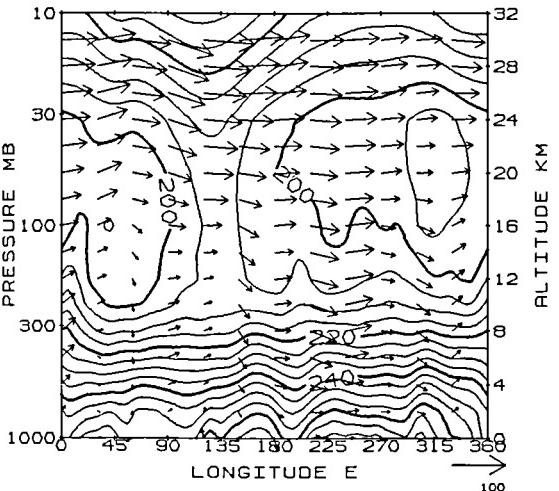
NMC PV AND THETA 9/ 7/87



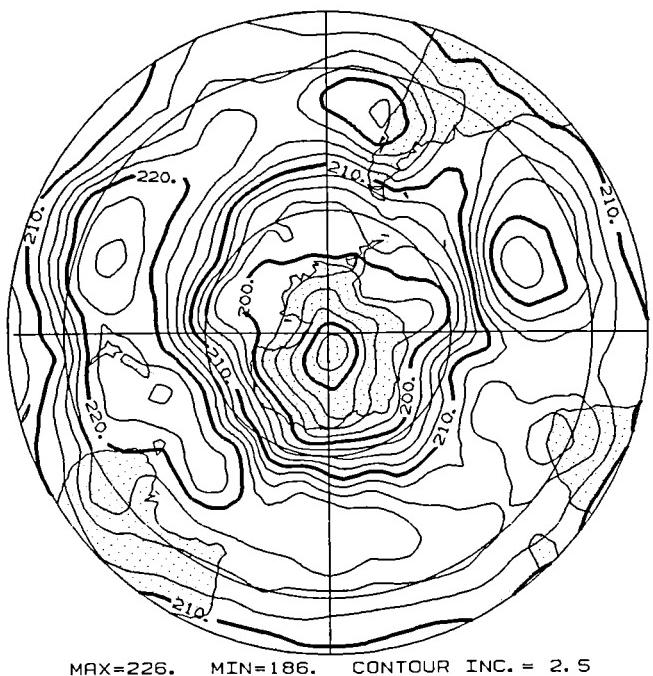
NMC 65W V (M/S) T (K) 9/ 7/87



NMC 65S TEMP AND WINDS 9/ 7/87



NMC 200-100 THICK. T O 9/ 8/87



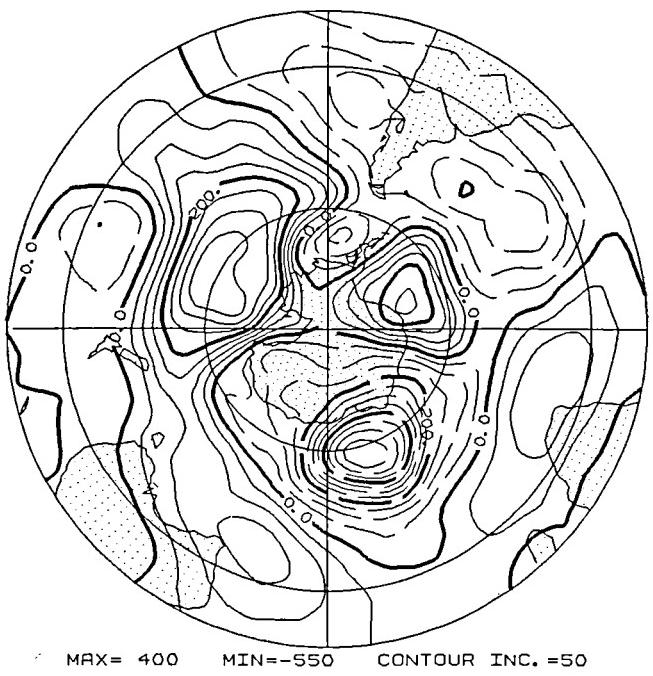
MAX=226. MIN=186. CONTOUR INC. = 2.5

TOMS TOTAL OZONE



MAX=430. MIN=174. CONTOUR INC. = 25.

NMC 100MB HGT DEV. 9/ 8/87

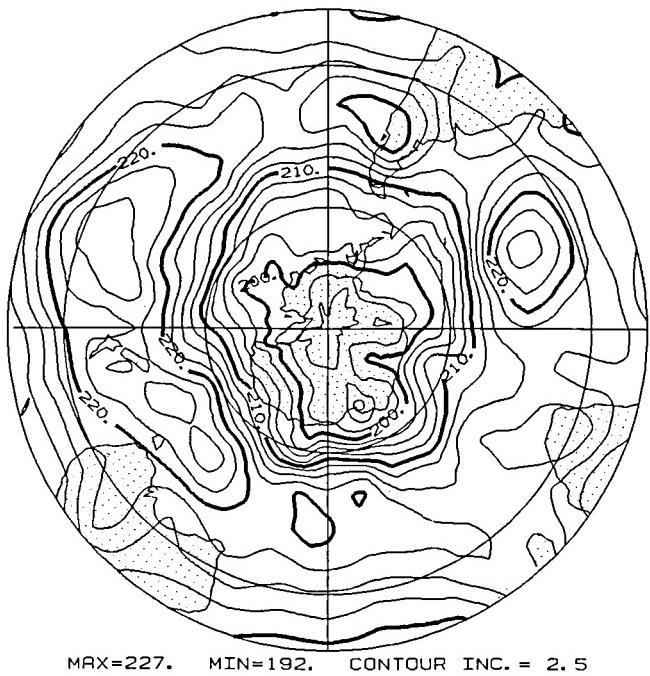


MAX= 400 MIN=-550 CONTOUR INC.=50

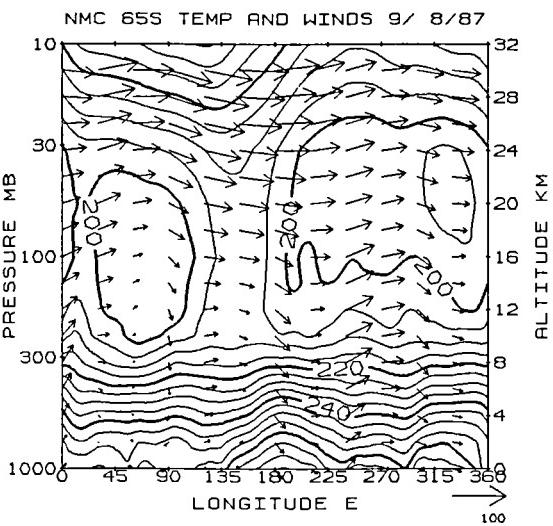
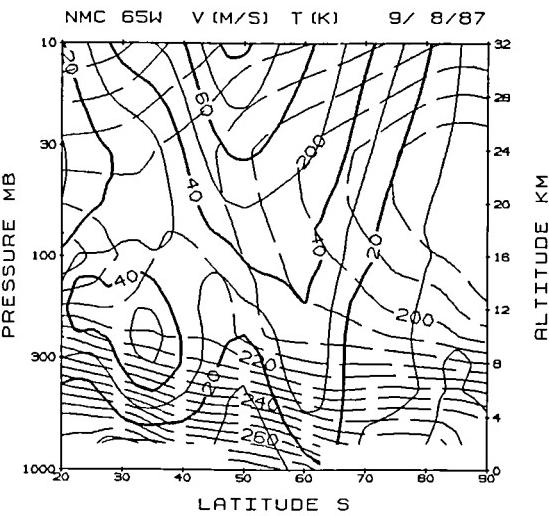
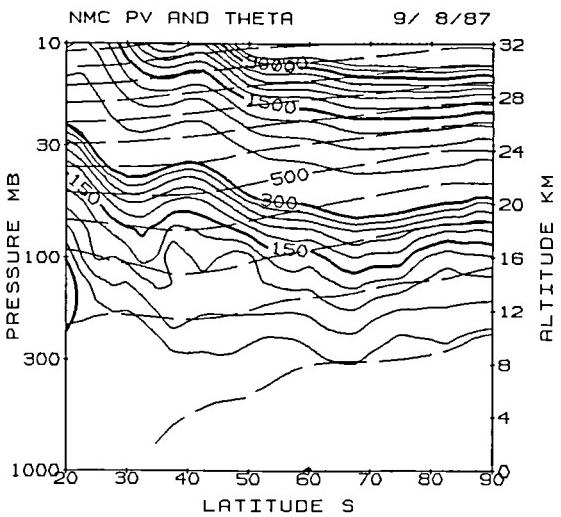
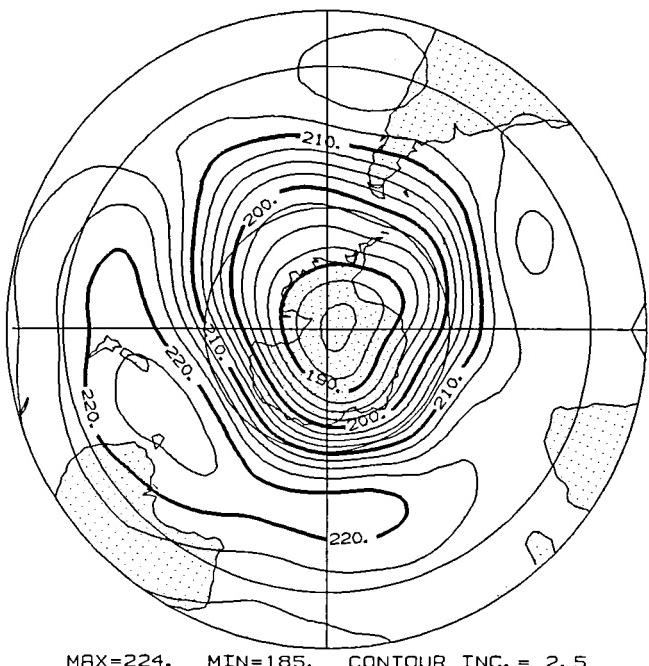
NMC 420K ERTEL POT VOR 9/ 8/87



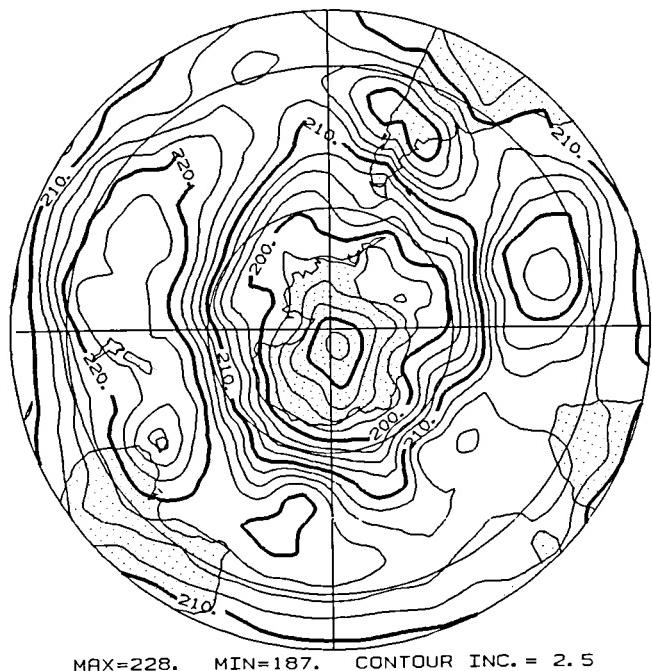
GLA 200-100 THICK. T 0 9/ 8/87



NMC 50-30MB THICKNESS 9/ 8/87



NMC 200-100 THICK. T 0 9/ 9/87



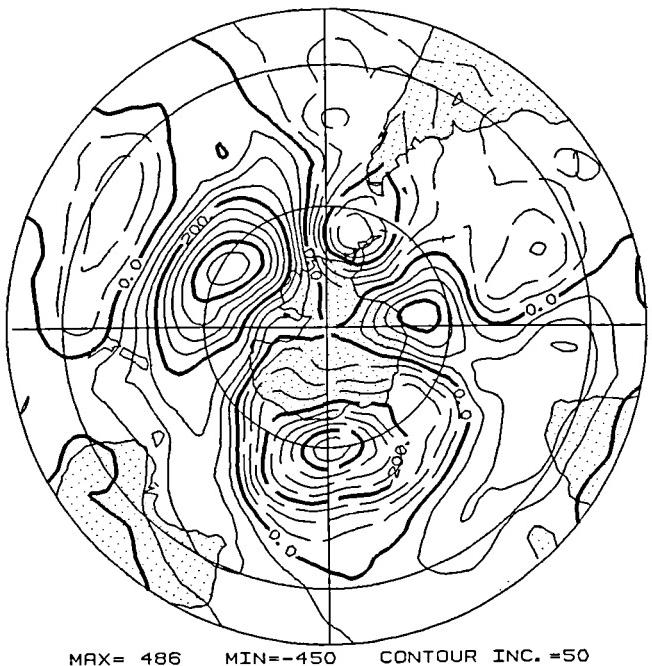
TOMS TOTAL OZONE

9/ 9/87



NMC 100MB HGT DEV.

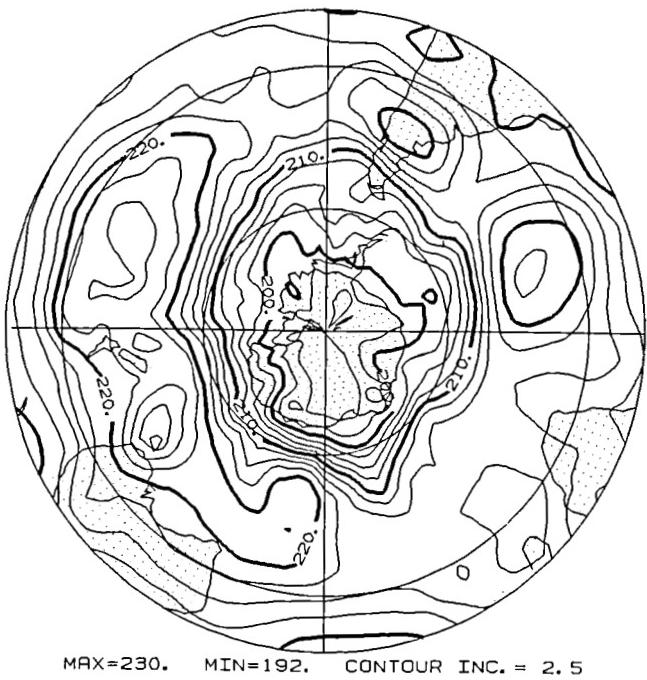
9/ 9/87



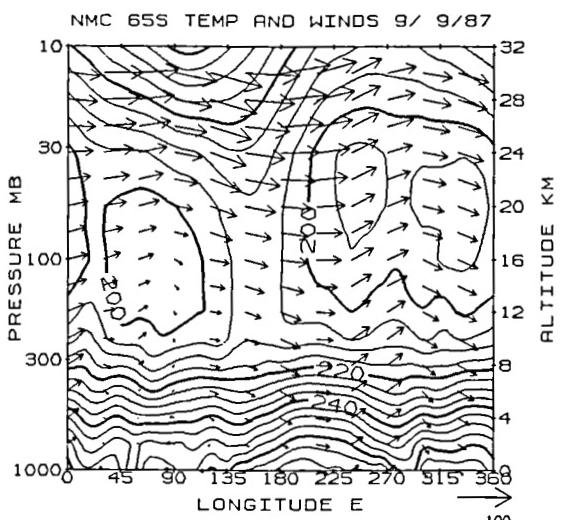
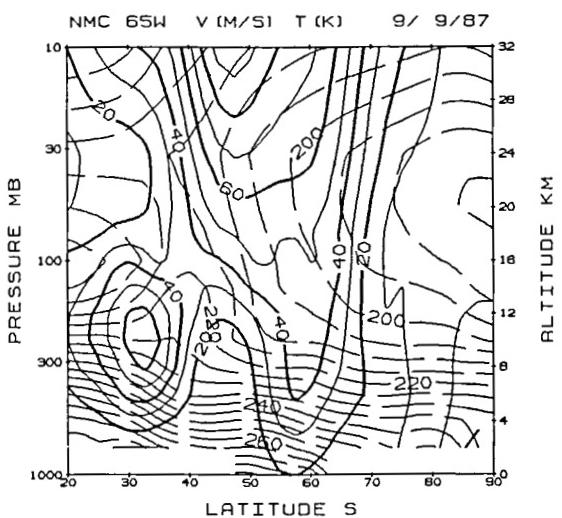
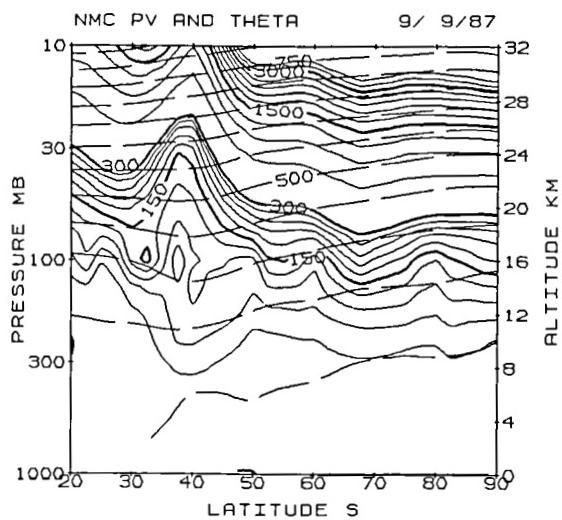
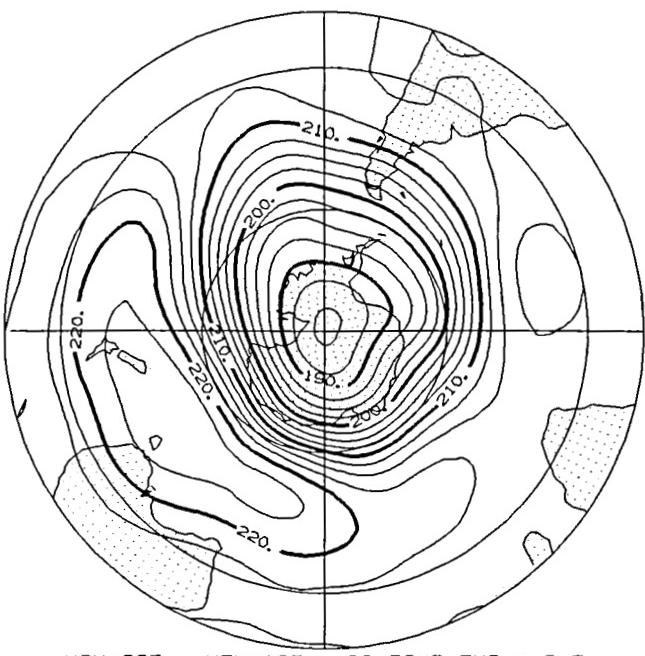
NMC 420K ERTEL POT VOR 9/ 9/87



GLA 200-100 THICK. T 0 9/ 9/87



NMC 50-30MB THICKNESS 9/ 9/87



NMC 200-100 THICK. T O 9/10/87



MAX=229. MIN=189. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

9/10/87



MAX=455. MIN=179. CONTOUR INC. = 25.

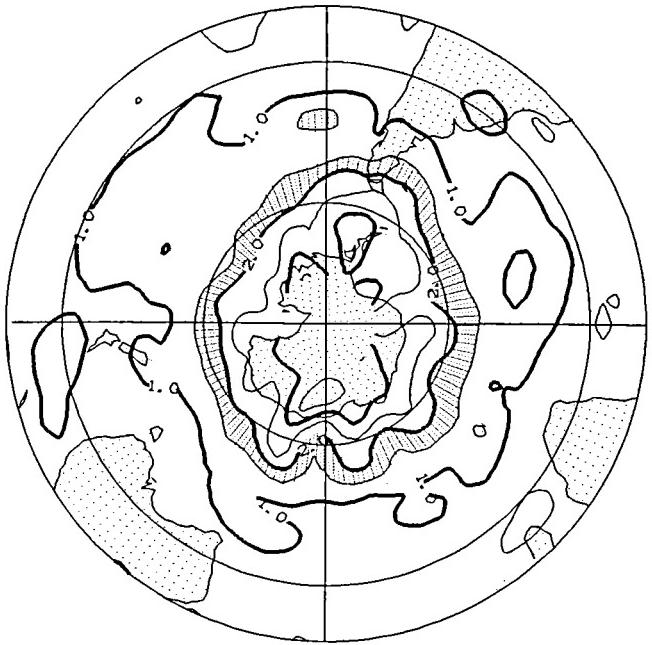
NMC 100MB HGT DEV.

9/10/87

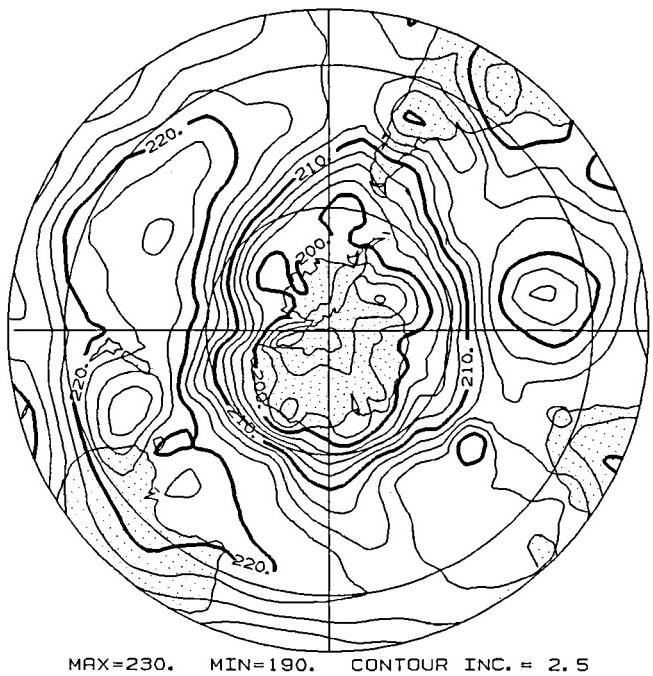


MAX= 444 MIN=-450 CONTOUR INC.=50

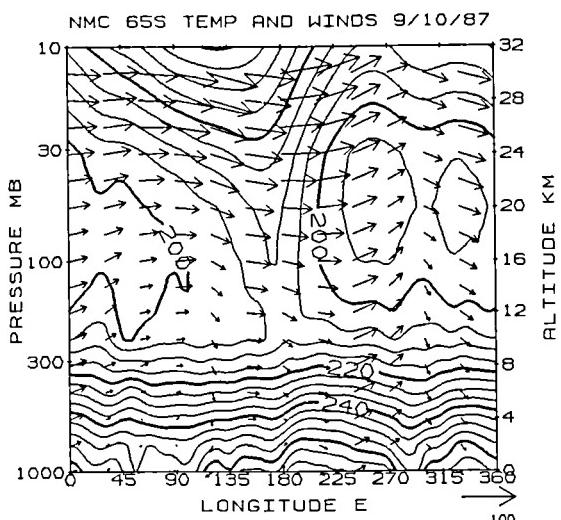
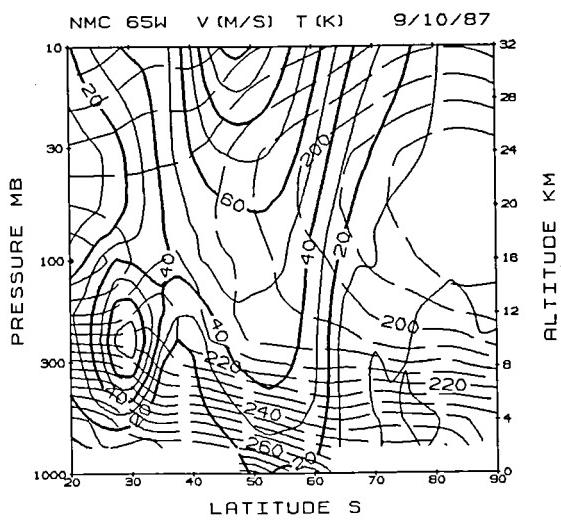
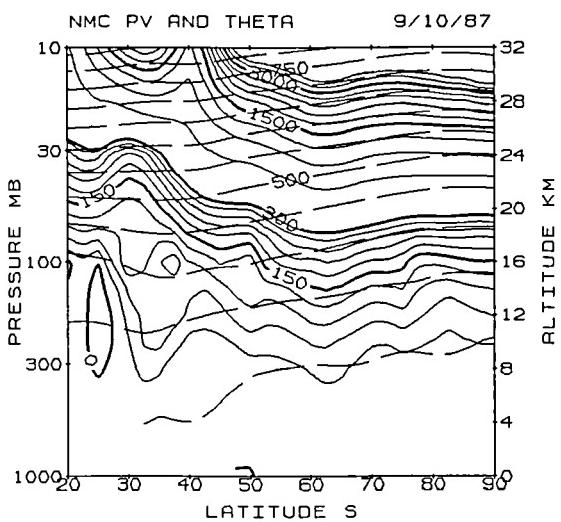
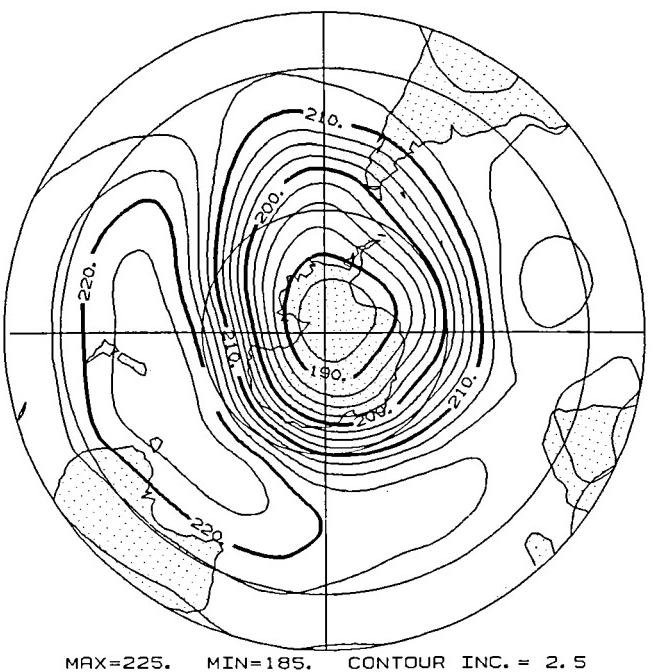
NMC 420K ERTEL POT VOR 9/10/87



GLA 200-100 THICK. T 0 9/10/87



NMC 50-30MB THICKNESS 9/10/87



NMC 200-100 THICK. T 0 9/11/87



MAX=229. MIN=187. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

9/11/87



MAX=452. MIN=171. CONTOUR INC. = 25.

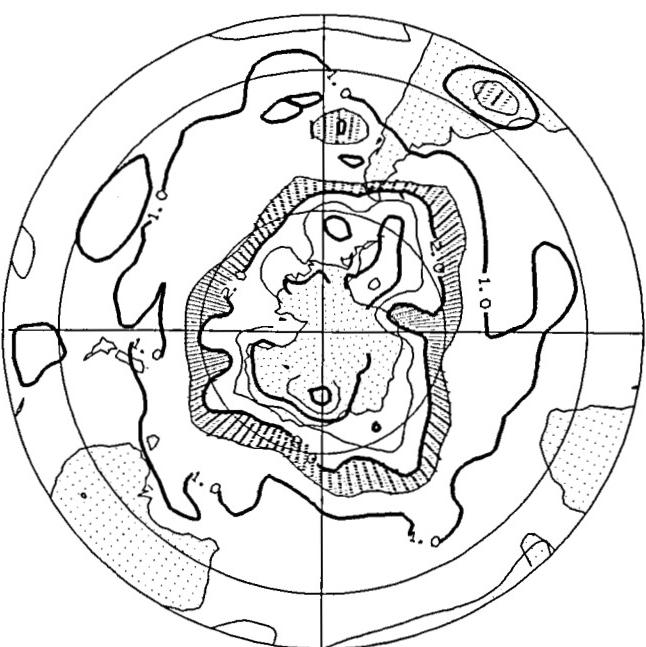
NMC 100MB HGT DEV.

9/11/87

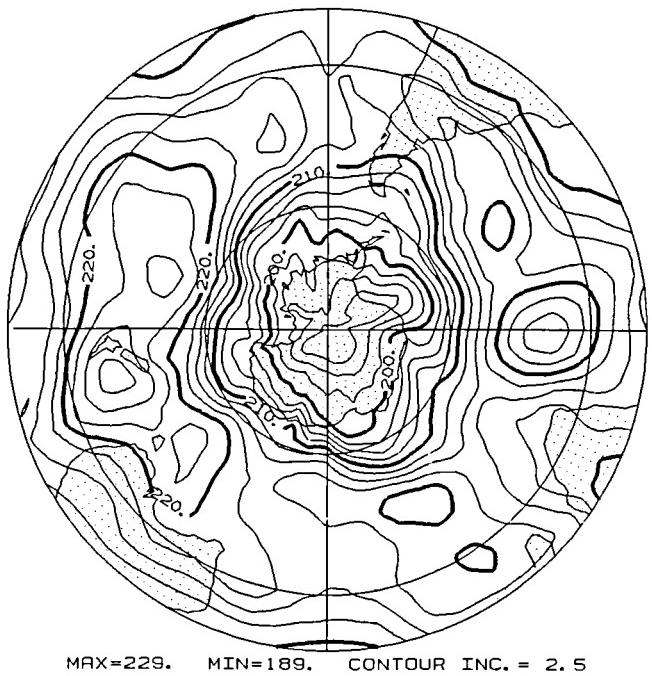


MAX= 367 MIN=-500 CONTOUR INC.=50

NMC 420K ERTEL POT VOR 9/11/87

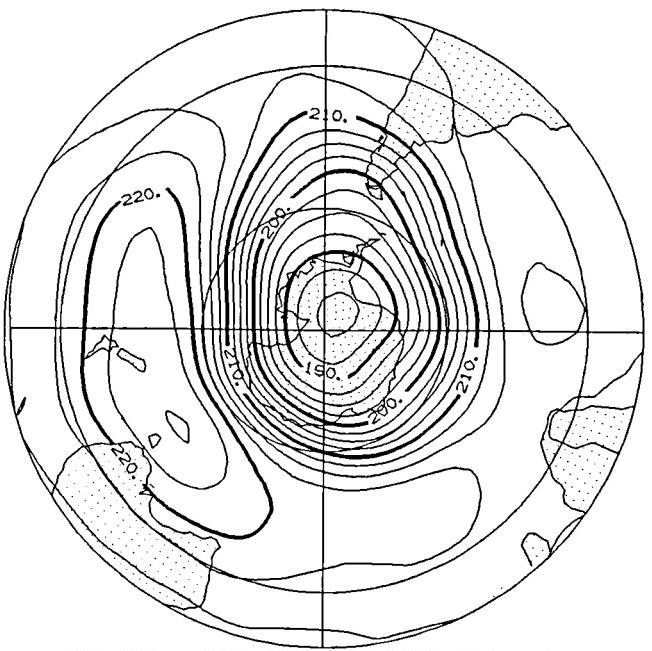


GLA 200-100 THICK. T O 9/11/87



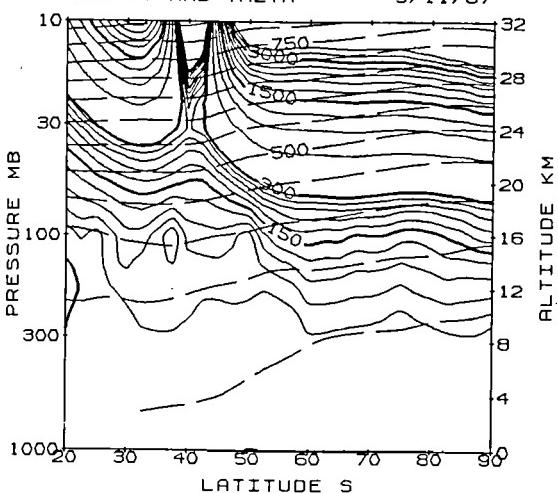
MAX=229. MIN=189. CONTOUR INC. = 2.5

NMC 50-30MB THICKNESS 9/11/87

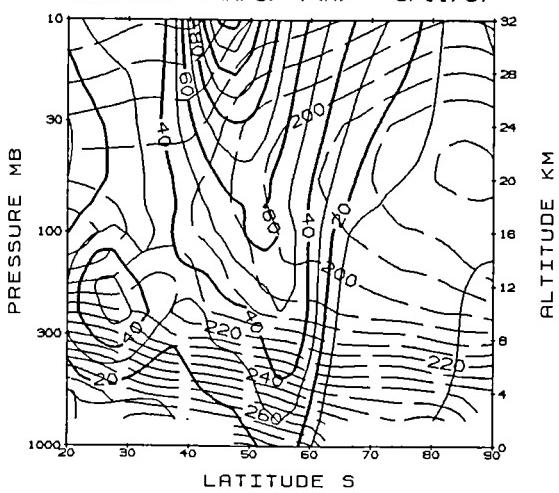


MAX=225. MIN=184. CONTOUR INC. = 2.5

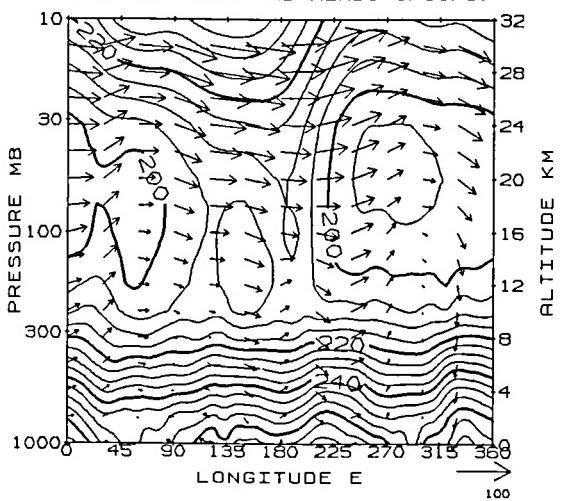
NMC PV AND THETA 9/11/87



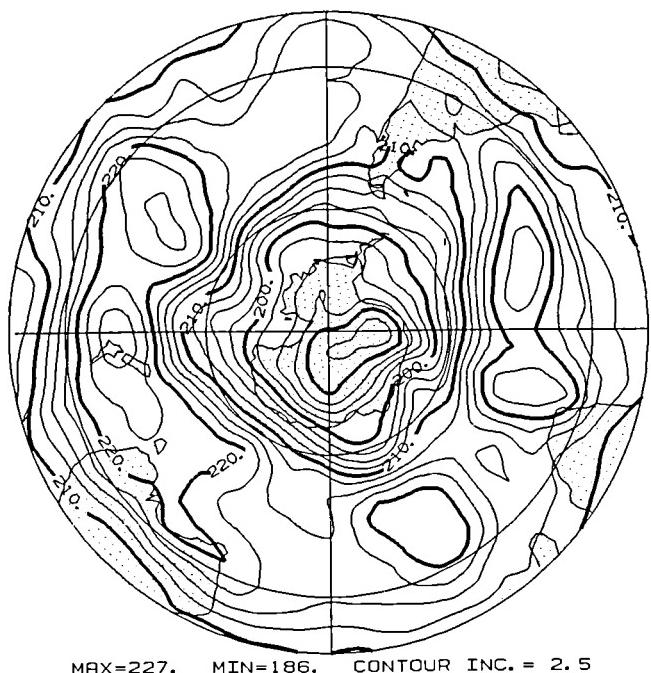
NMC 65W V (M/S) T (K) 9/11/87



NMC 65S TEMP AND WINDS 9/11/87



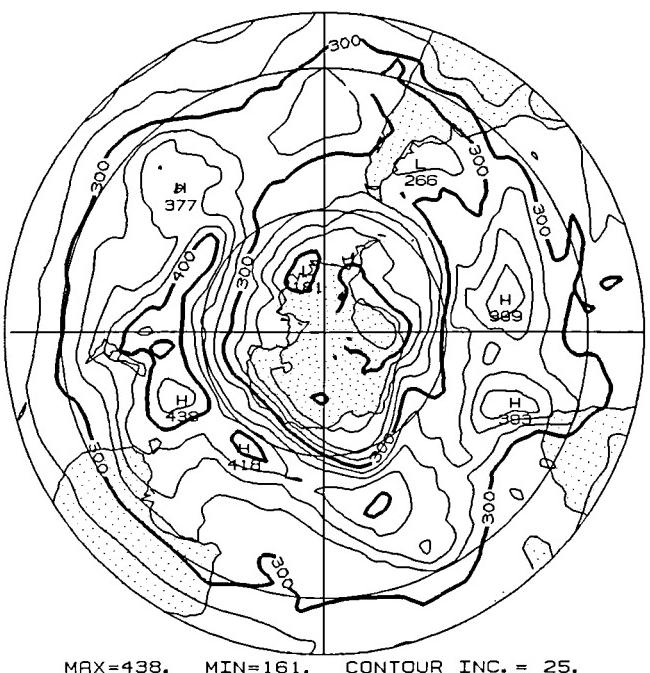
NMC 200-100 THICK. T 0 9/12/87



MAX=227. MIN=186. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

9/12/87



MAX=438. MIN=161. CONTOUR INC. = 25.

NMC 100MB HGT DEV.

9/12/87

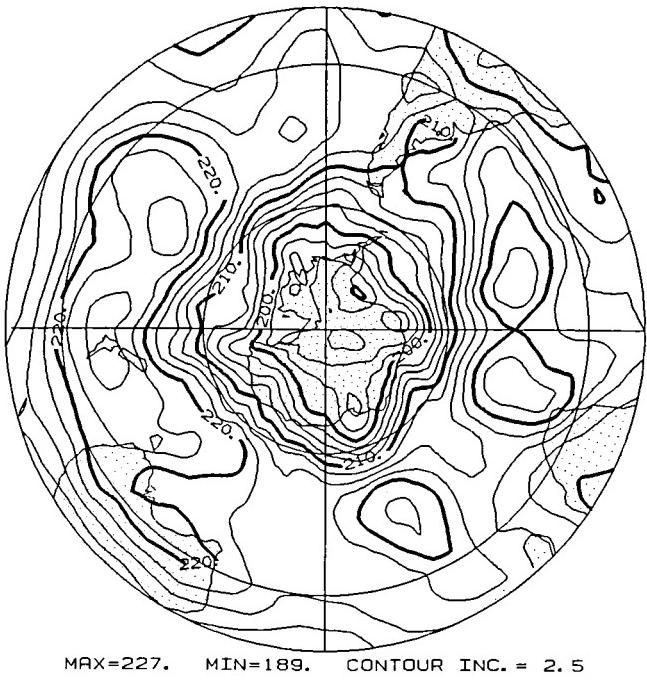


MAX= 358 MIN=-450 CONTOUR INC. =50

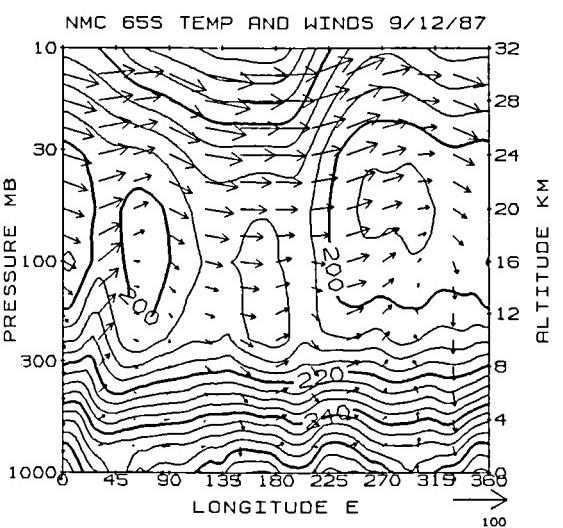
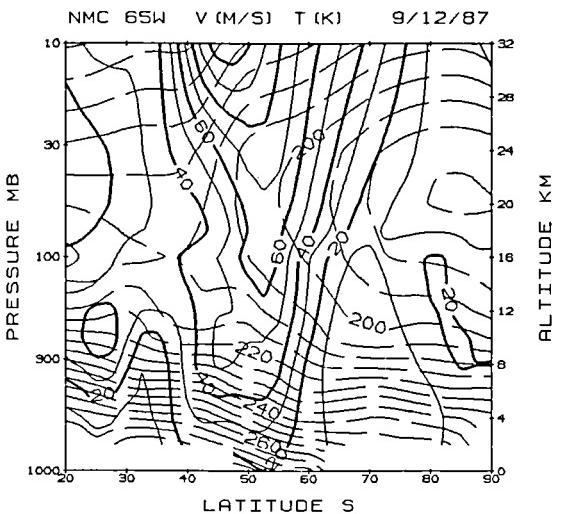
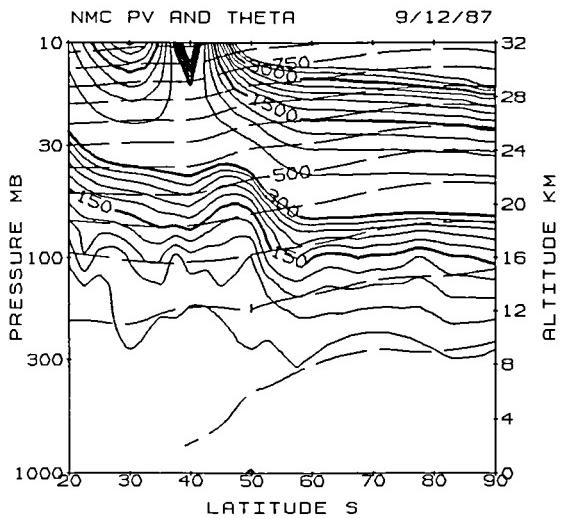
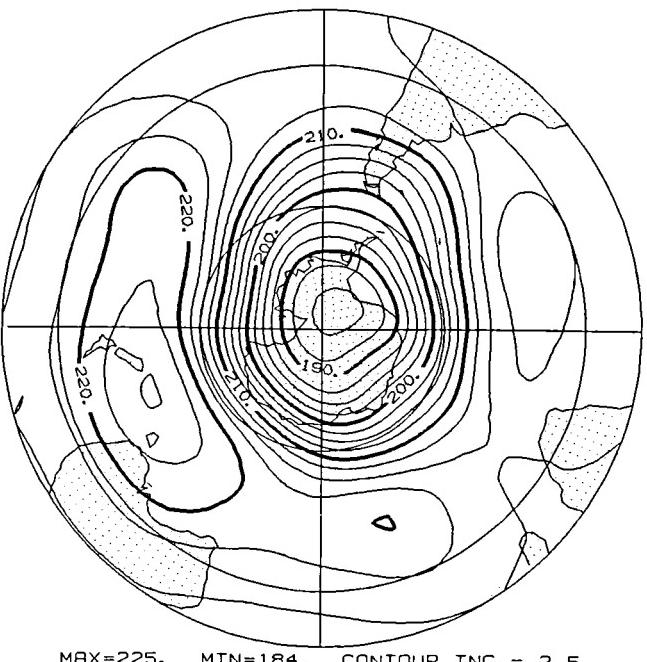
NMC 420K ERTEL POT VOR 9/12/87



GLA 200-100 THICK. T O 9/12/87



NMC 50-30MB THICKNESS 9/12/87



NMC 200-100 THICK. T 0 9/13/87



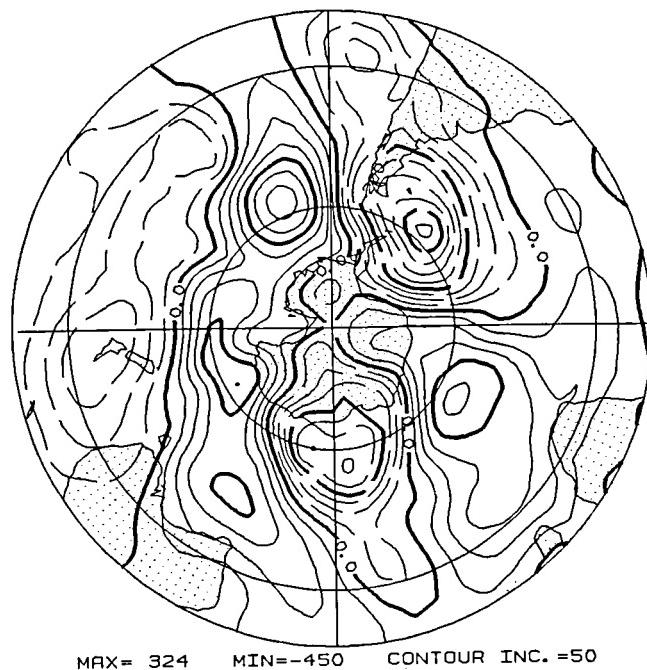
TOMS TOTAL OZONE

9/13/87



NMC 100MB HGT DEV.

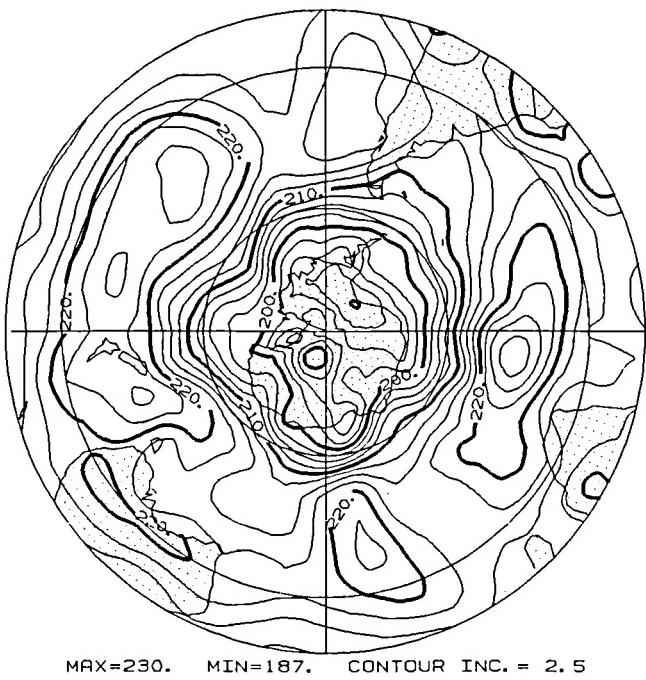
9/13/87



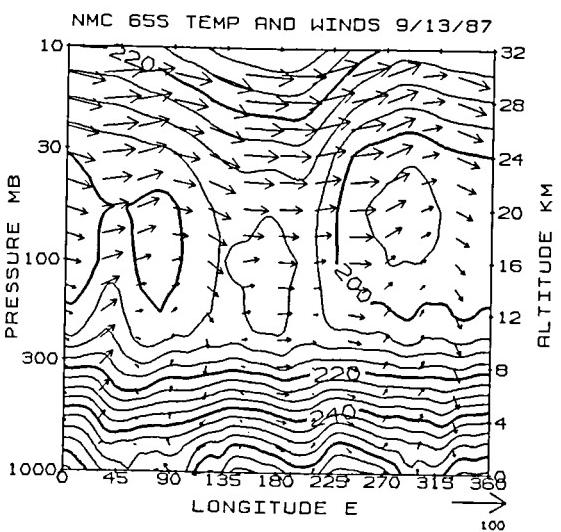
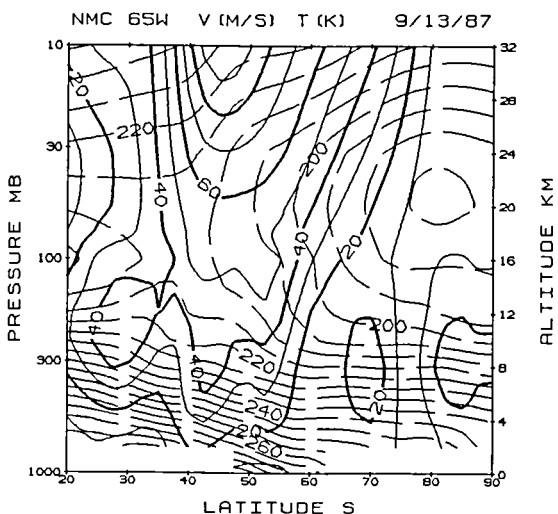
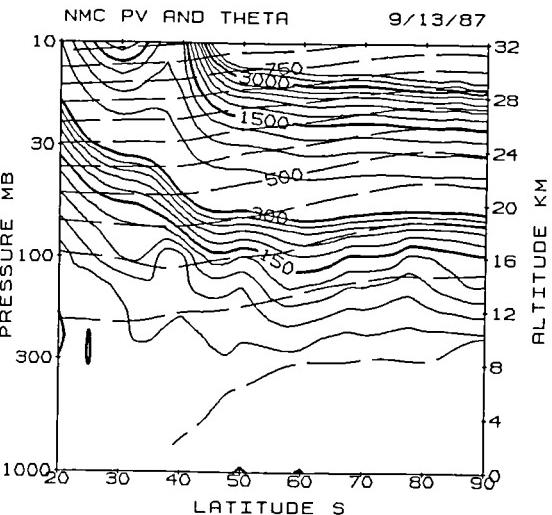
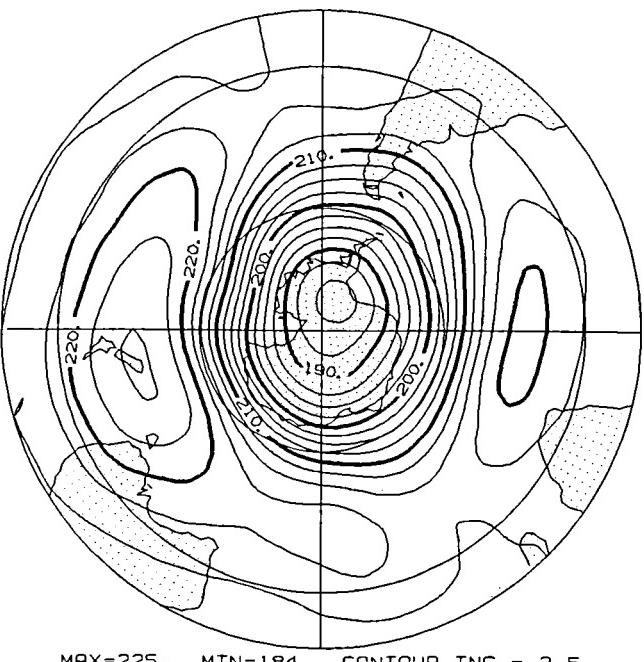
NMC 420K ERTEL POT VOR 9/13/87



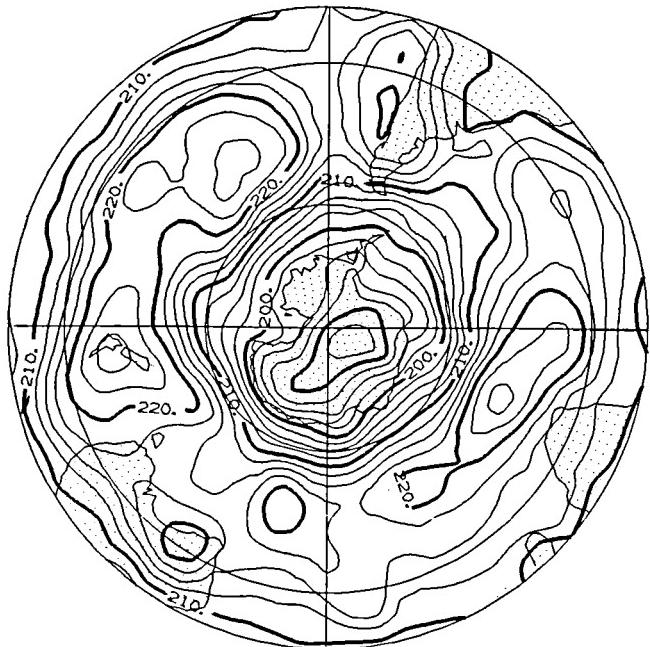
GLA 200-100 THICK. T 0 9/13/87



NMC 50-30MB THICKNESS 9/13/87

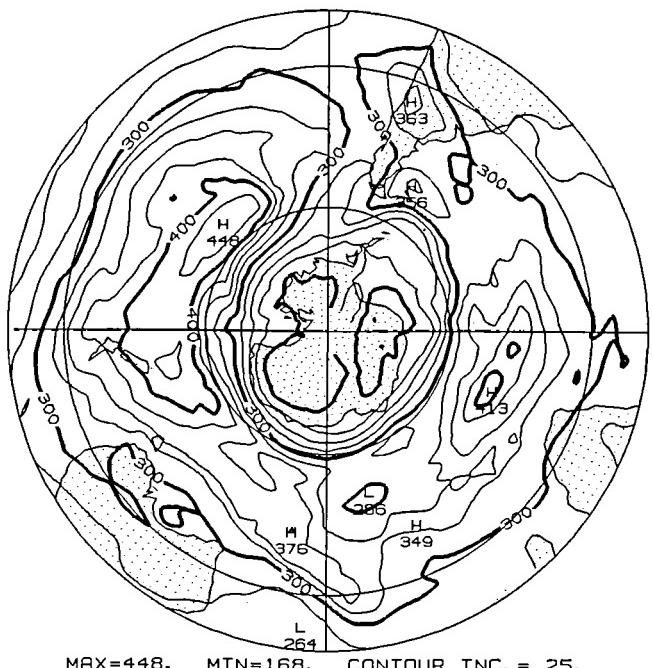


NMC 200-100 THICK. T 0 9/14/87



MAX=226. MIN=186. CONTOUR INC. = 2.5

TOMS TOTAL OZONE



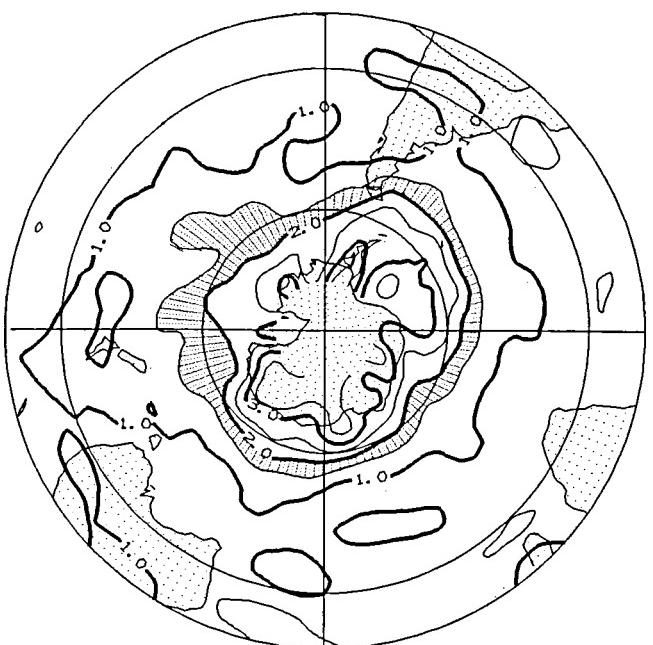
MAX=448. MIN=168. CONTOUR INC. = 25.

NMC 100MB HGT DEV. 9/14/87

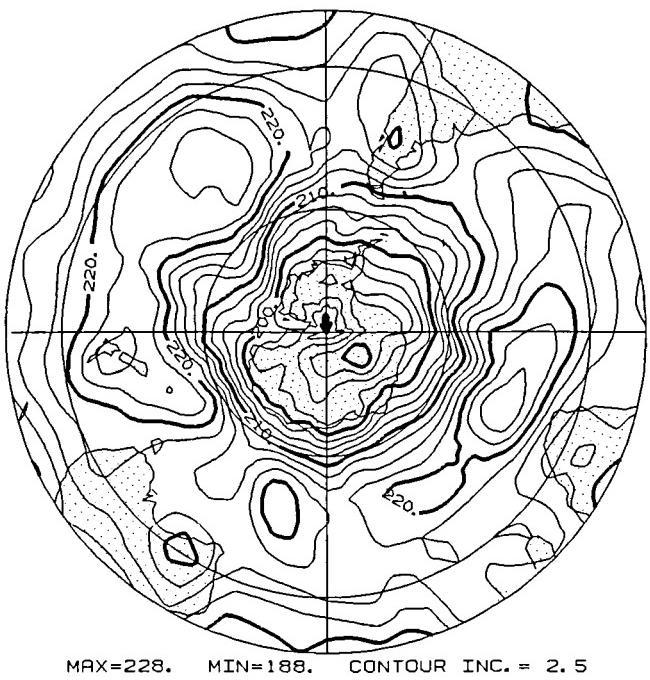


MAX= 379 MIN=-400 CONTOUR INC. =50

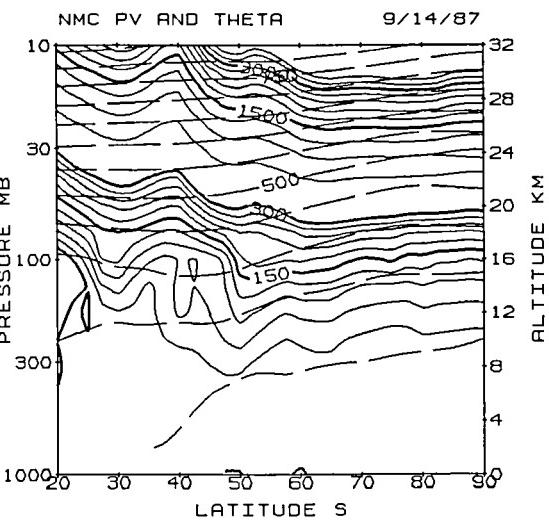
NMC 420K ERTEL POT VOR 9/14/87



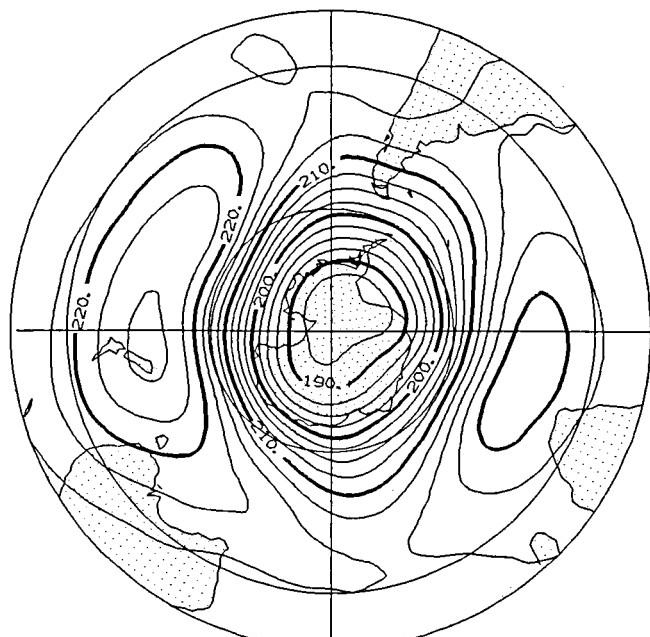
GLA 200-100 THICK. T O 9/14/87



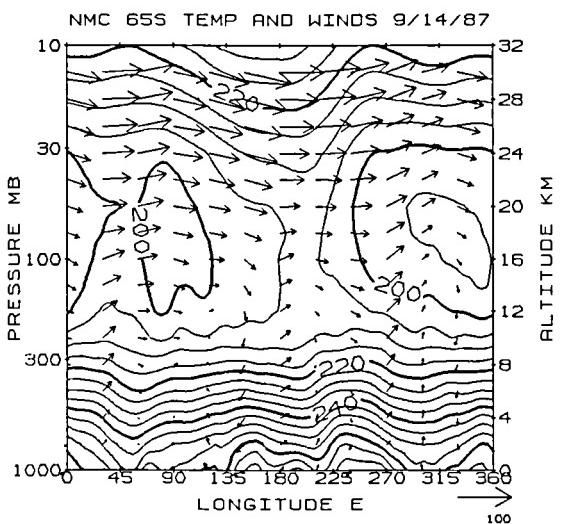
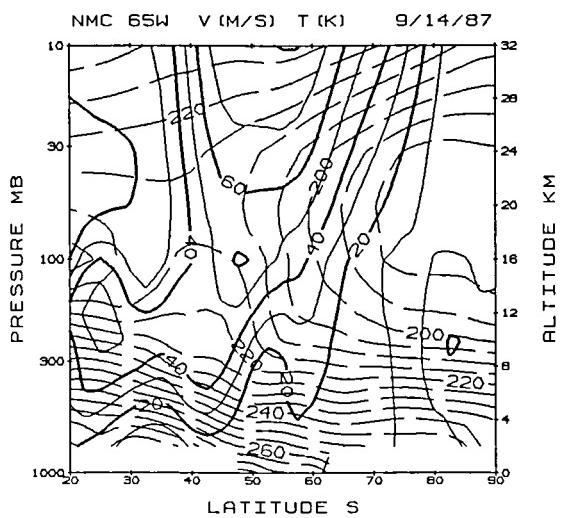
MAX=228. MIN=188. CONTOUR INC. = 2.5



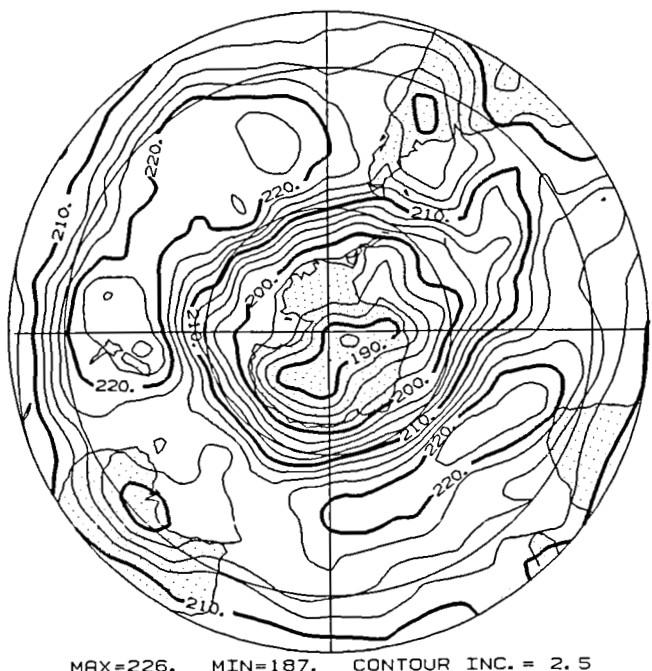
NMC 50-30MB THICKNESS 9/14/87



MAX=226. MIN=185. CONTOUR INC. = 2.5

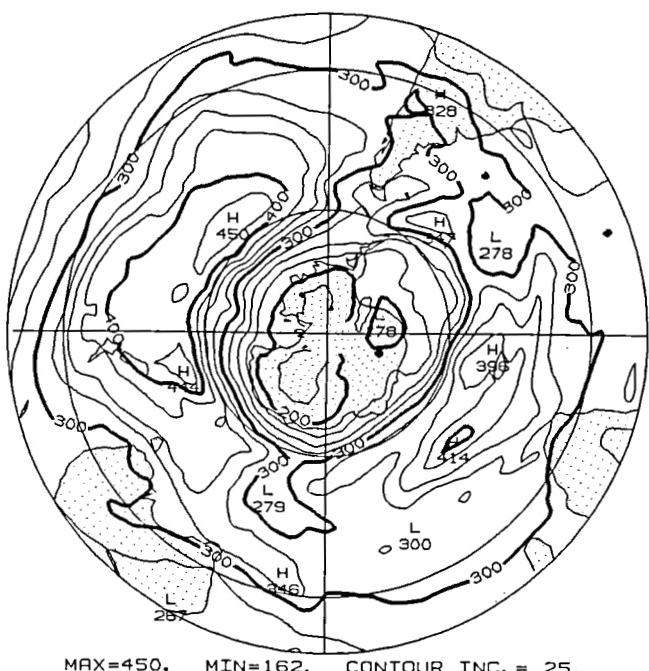


NMC 200-100 THICK. T 0 9/15/87



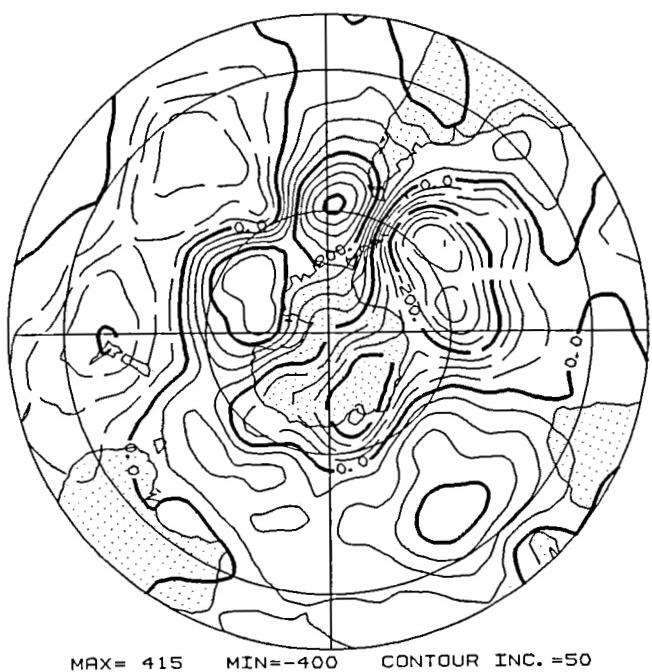
TOMS TOTAL OZONE

9/15/87



NMC 100MB HGT DEV.

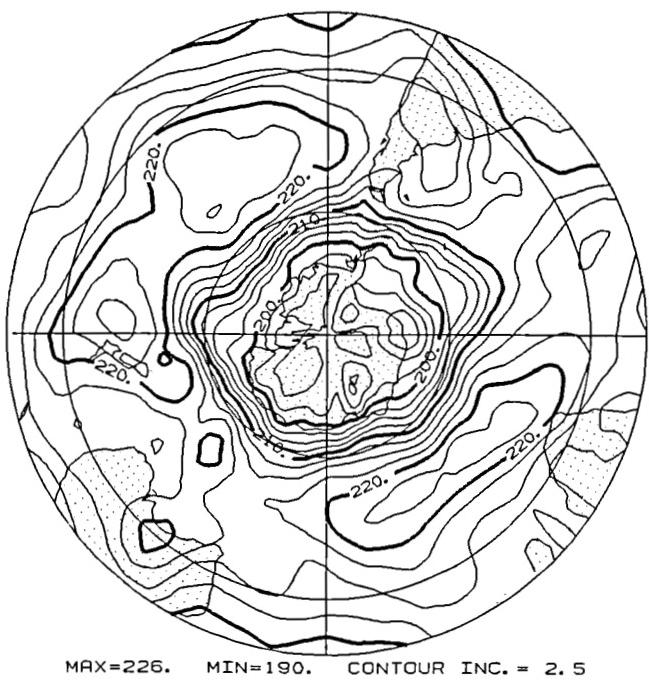
9/15/87



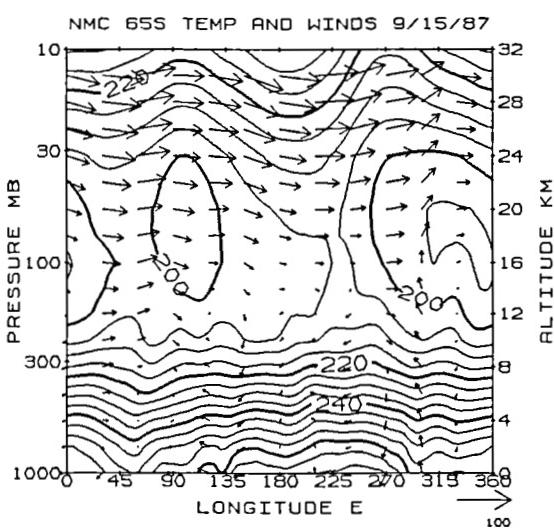
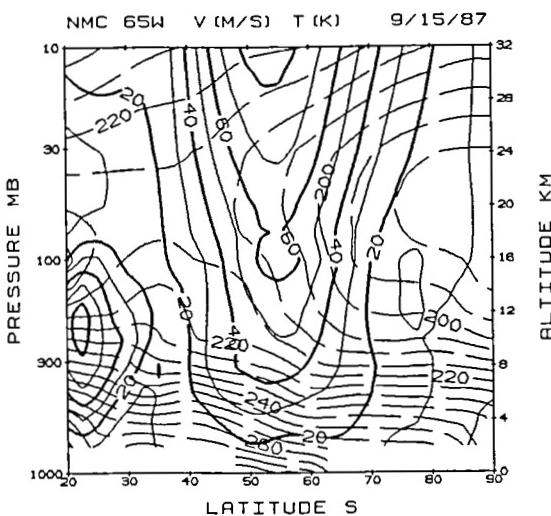
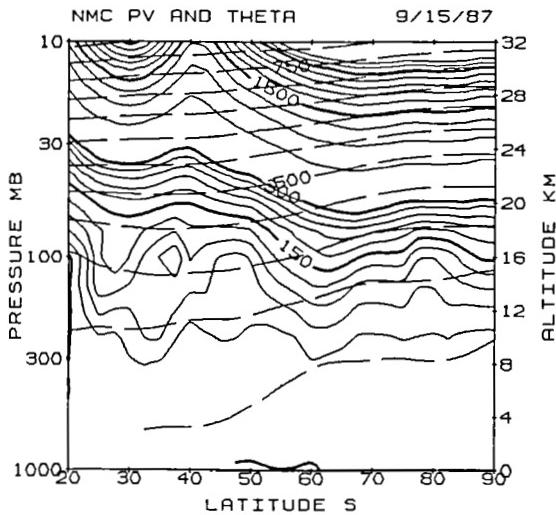
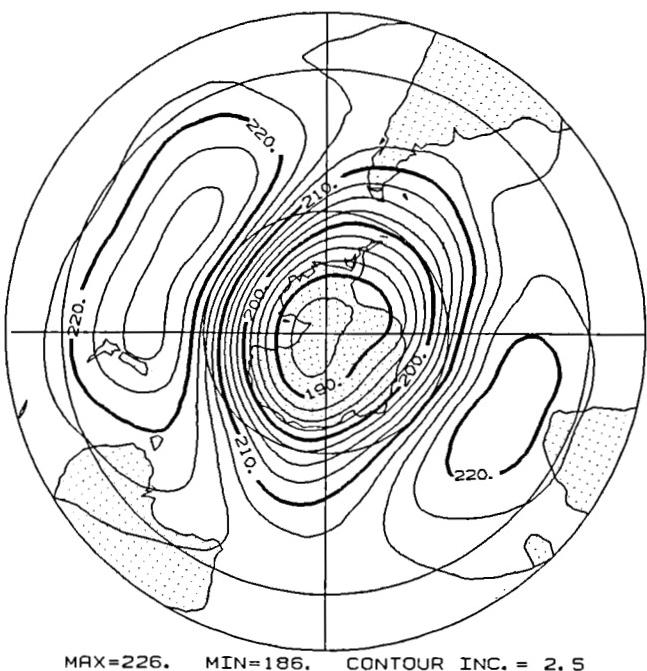
NMC 420K ERTEL POT VOR 9/15/87



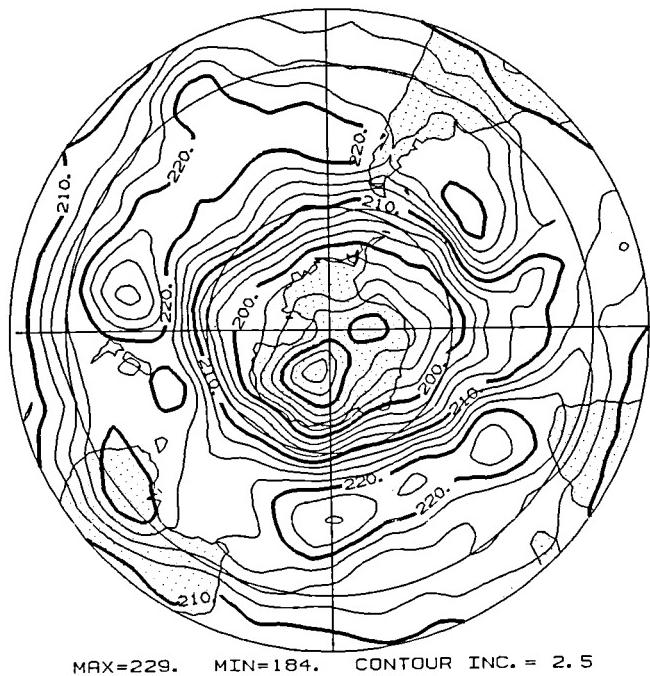
GLA 200-100 THICK. T O 9/15/87



NMC 50-30MB THICKNESS 9/15/87

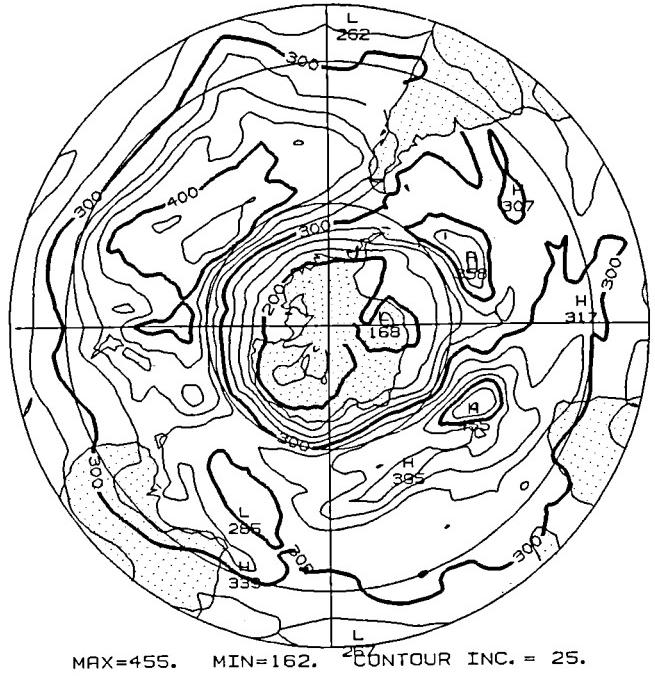


NMC 200-100 THICK. T 0 9/16/87



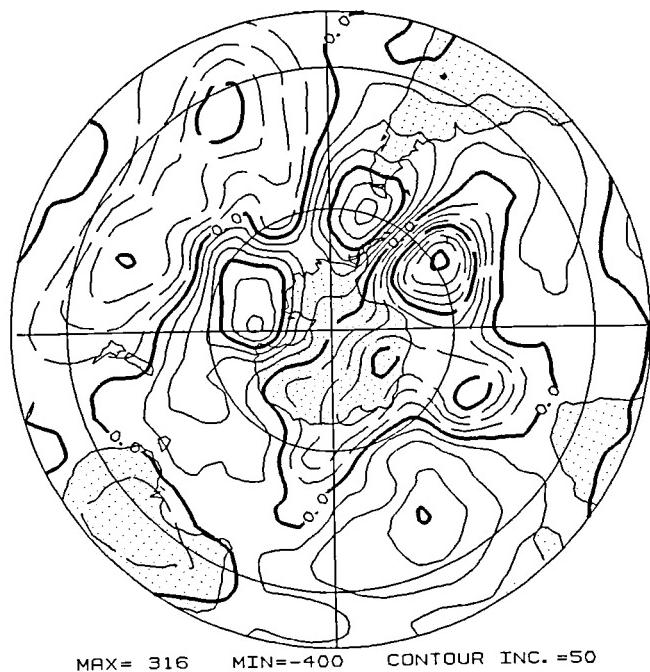
TOMS TOTAL OZONE

9/16/87



NMC 100MB HGT DEV.

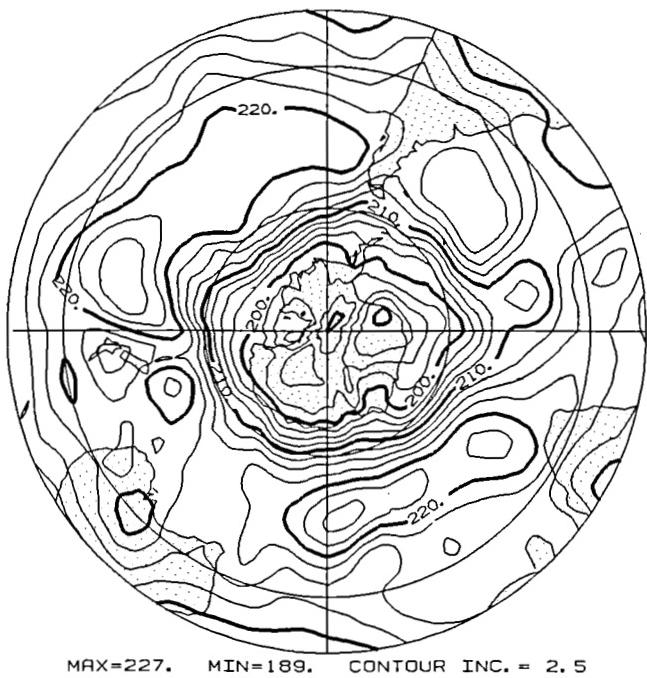
9/16/87



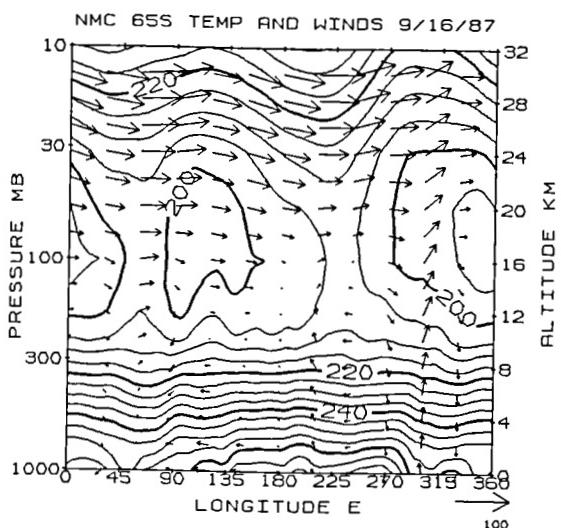
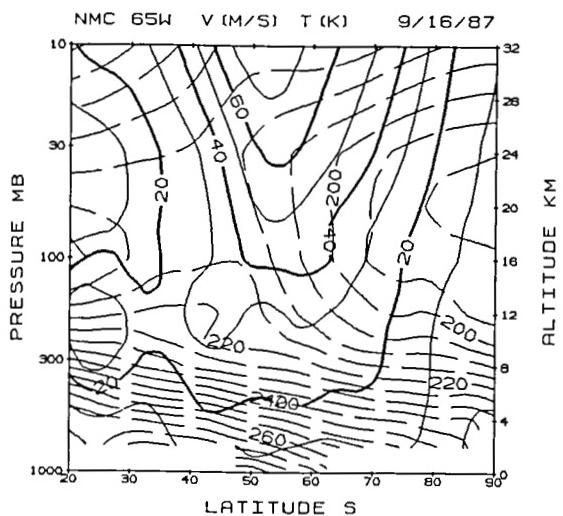
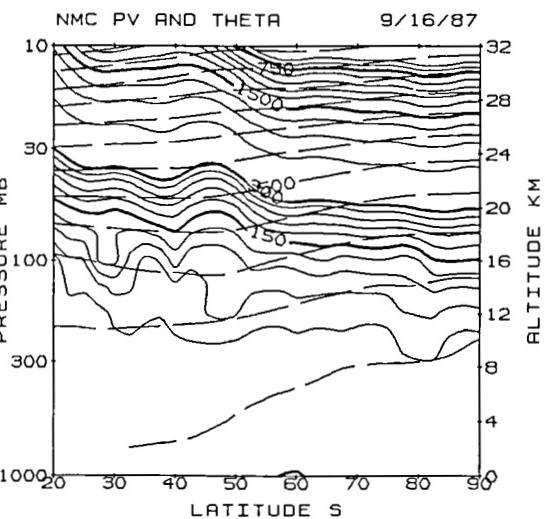
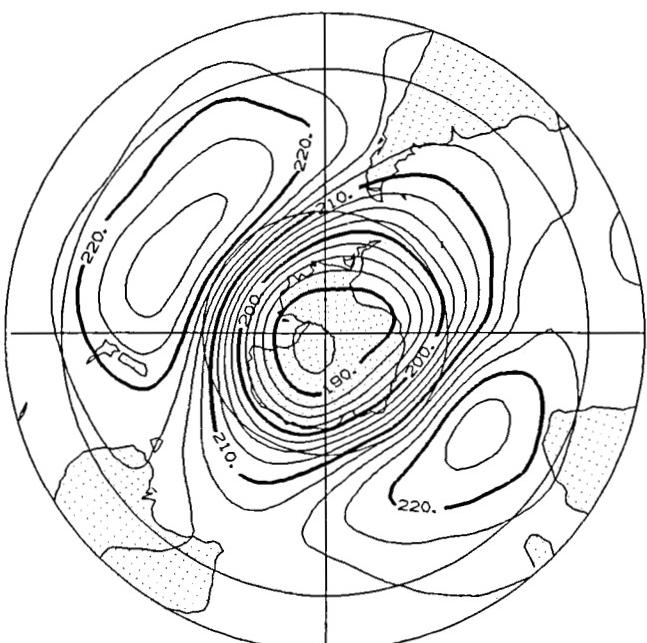
NMC 420K ERTEL POT VOR 9/16/87



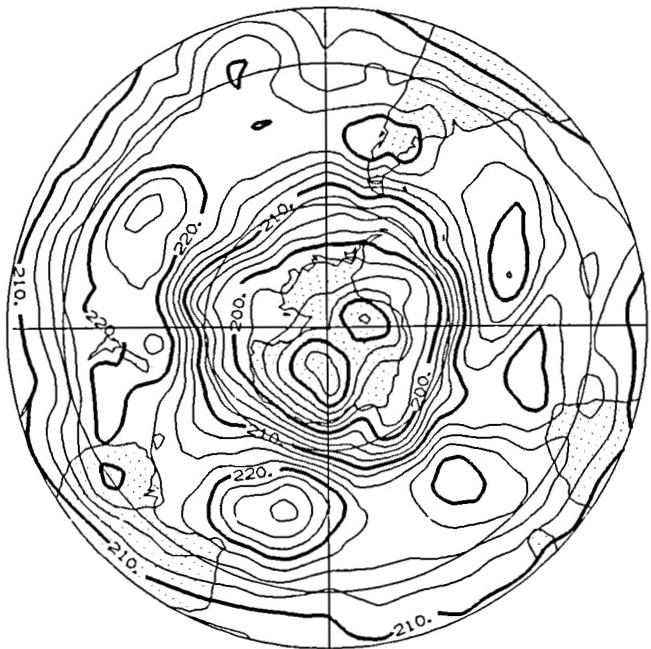
GLA 200-100 THICK. T O 9/16/87



NMC 50-30MB THICKNESS 9/16/87



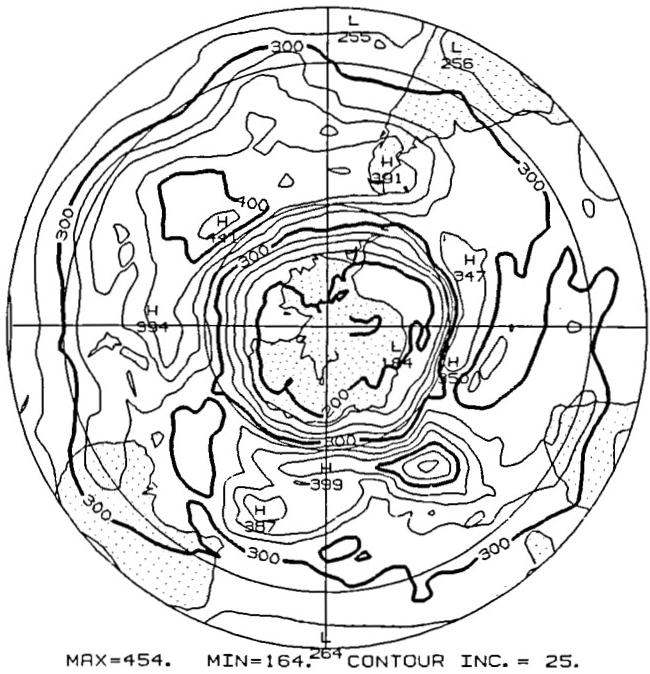
NMC 200-100 THICK. T O 9/17/87



MAX=228. MIN=186. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

9/17/87



MAX=454. MIN=164. CONTOUR INC. = 25.

NMC 100MB HGT DEV.

9/17/87

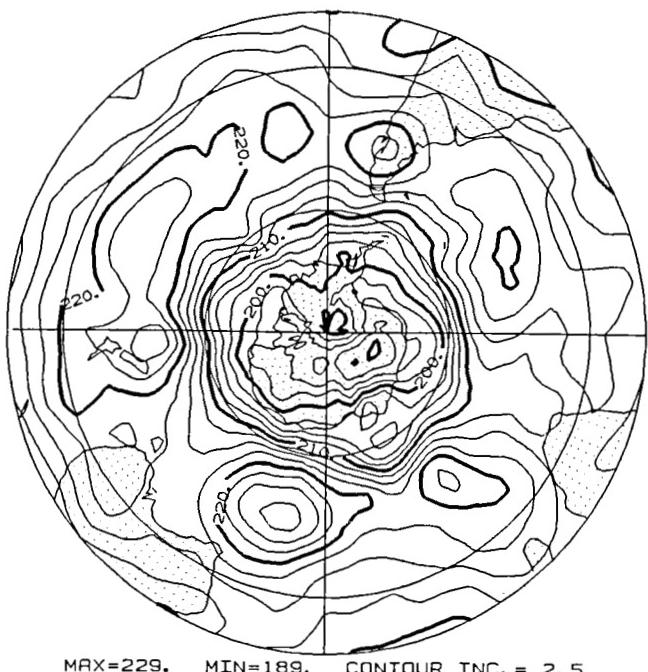


MAX= 285 MIN=-250 CONTOUR INC.=50

NMC 420K ERTEL POT VOR 9/17/87



GLA 200-100 THICK. T O 9/17/87

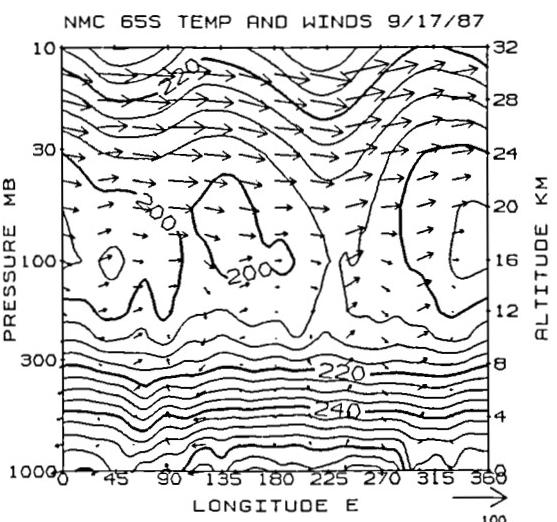
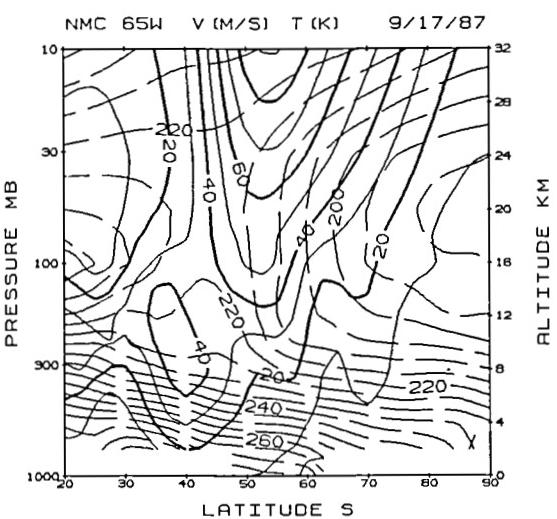
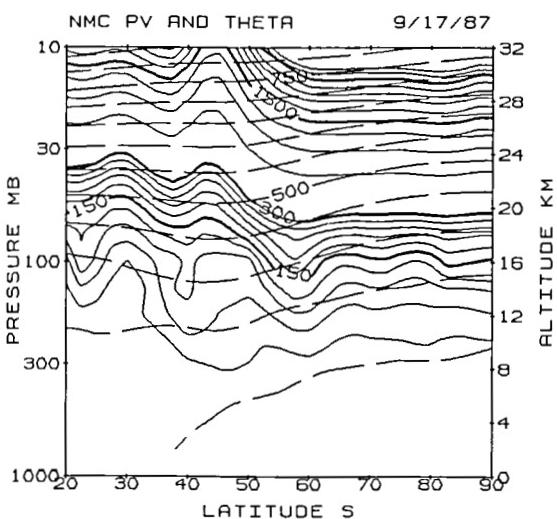


MAX=229. MIN=189. CONTOUR INC. = 2.5

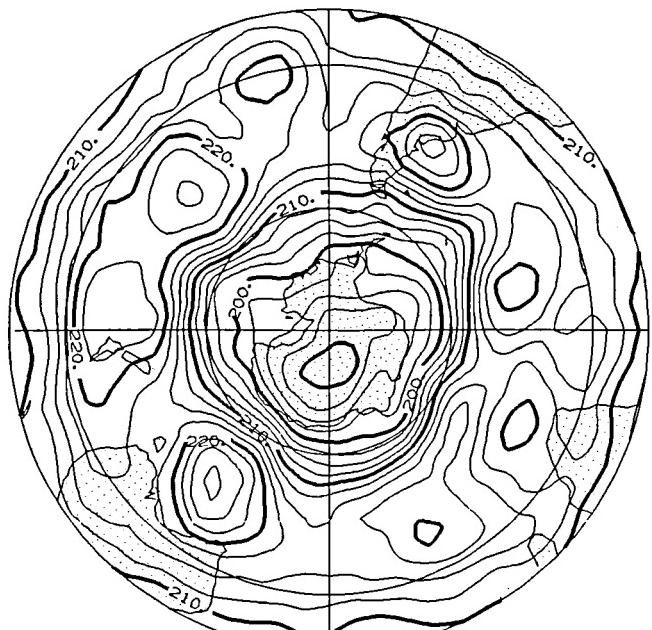
NMC 50-30MB THICKNESS 9/17/87



MAX=226. MIN=187. CONTOUR INC. = 2.5

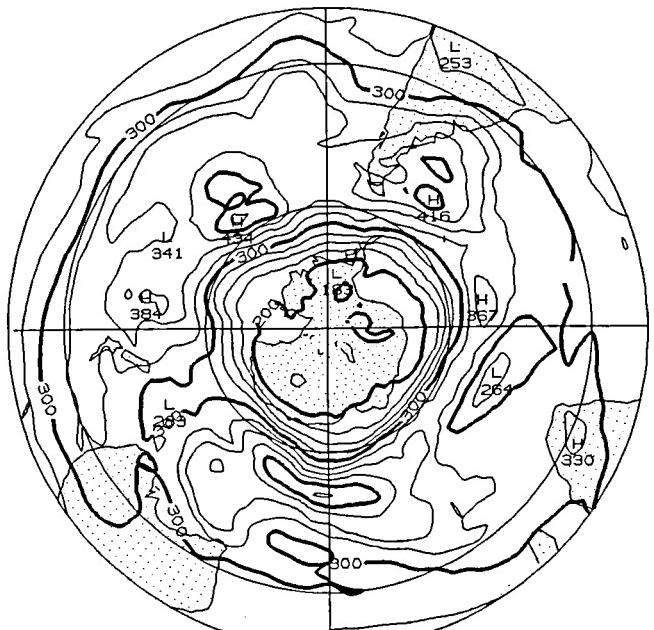


NMC 200-100 THICK. T O 9/18/87



MAX=228. MIN=188. CONTOUR INC. = 2.5

TOMS TOTAL OZONE



MAX=434. MIN=166. CONTOUR INC. = 25.

NMC 100MB HGT DEV. 9/18/87

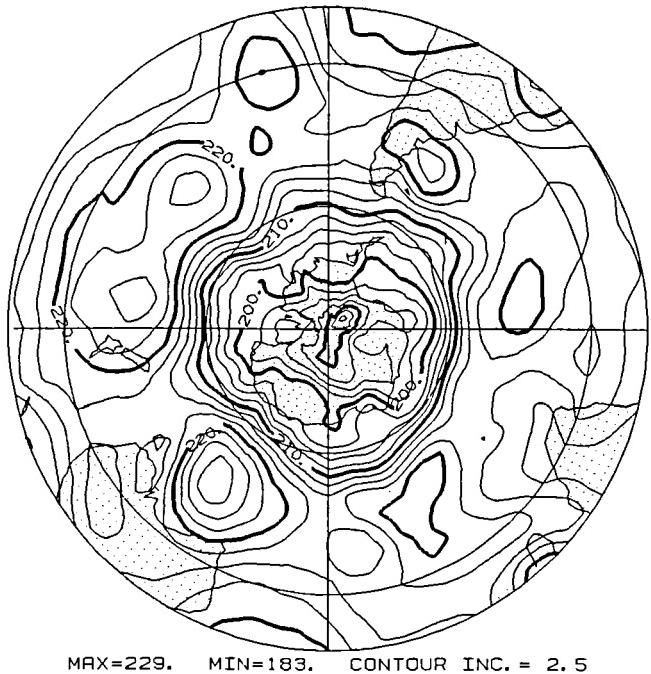


MAX= 394 MIN=-350 CONTOUR INC. =50

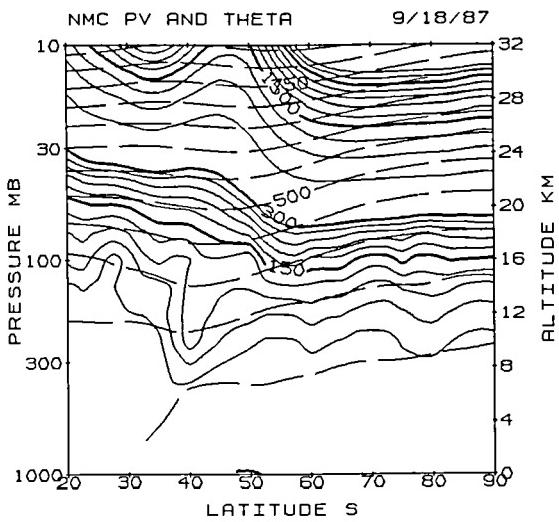
NMC 420K ERTEL POT VOR 9/18/87



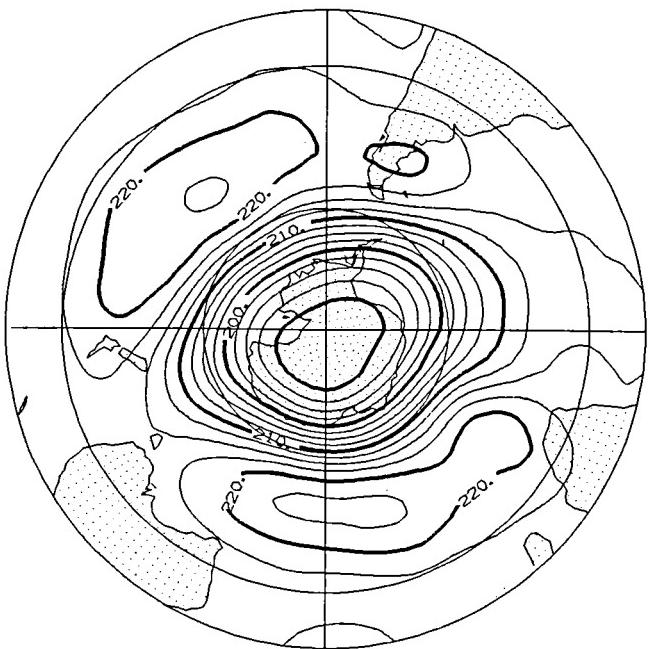
GLA 200-100 THICK. T O 9/18/87



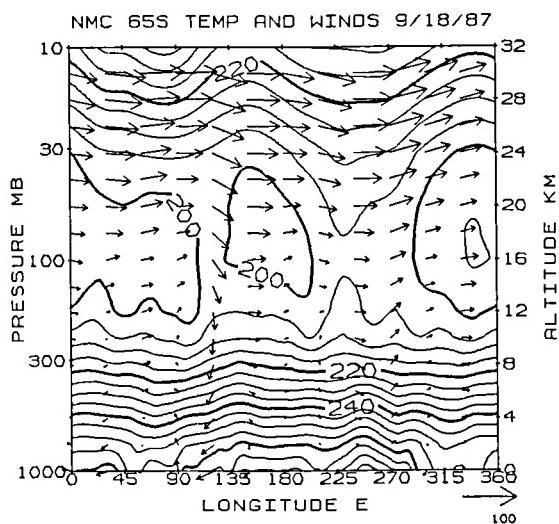
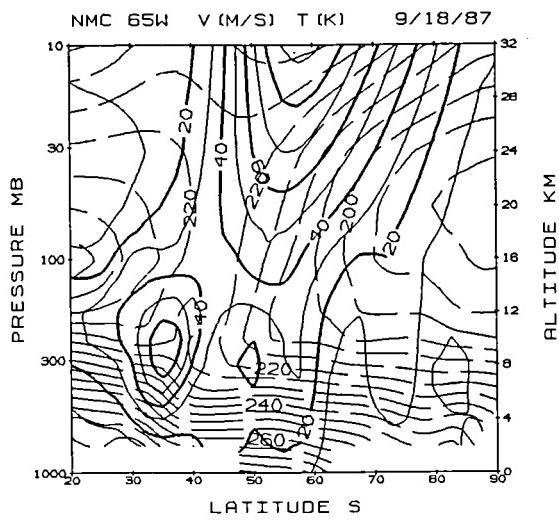
MAX=229. MIN=183. CONTOUR INC. = 2.5



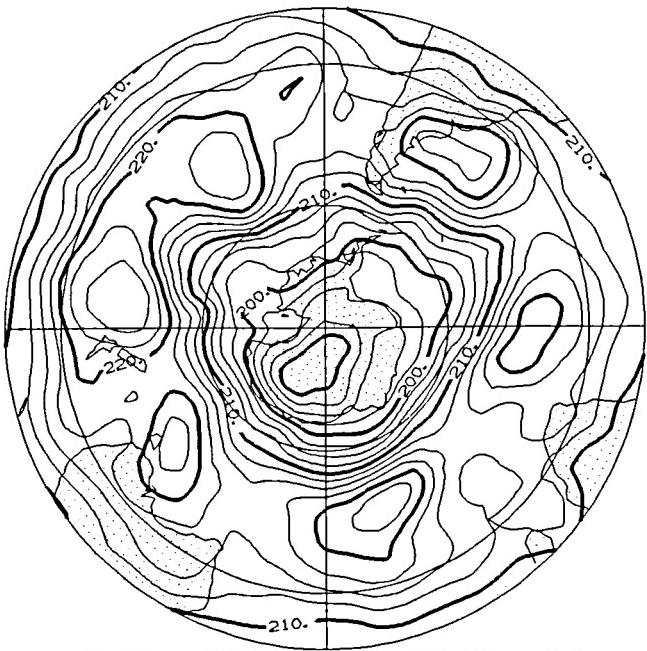
NMC 50-30MB THICKNESS 9/18/87



MAX=223. MIN=188. CONTOUR INC. = 2.5



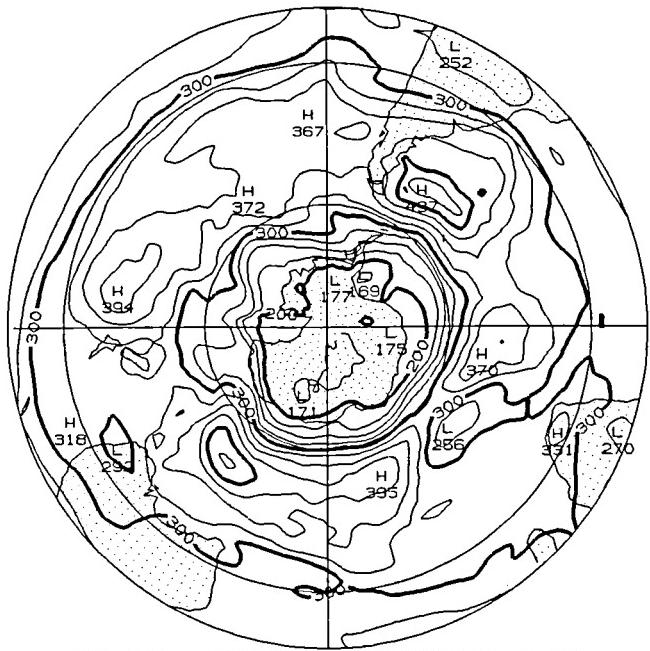
NMC 200-100 THICK. T 0 9/19/87



MAX=227. MIN=188. CONTOUR INC. = 2.5

TOMS TOTAL OZONE

9/19/87



MAX=437. MIN=166. CONTOUR INC. = 25.

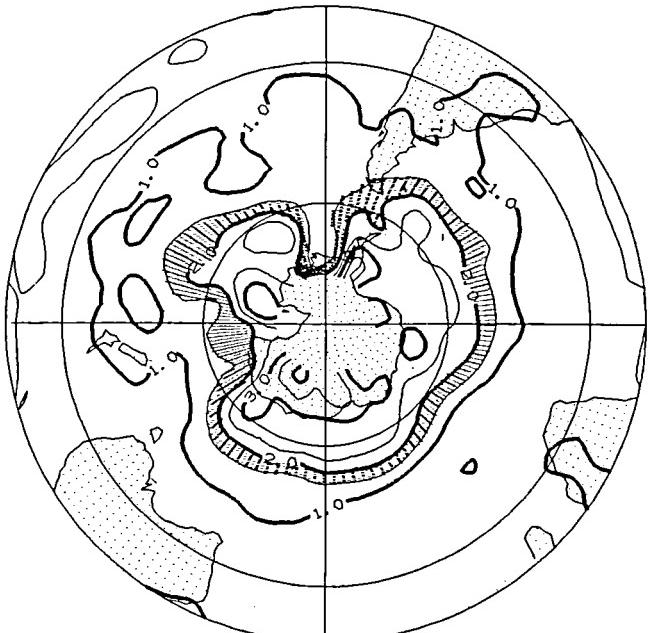
NMC 100MB HGT DEV.

9/19/87

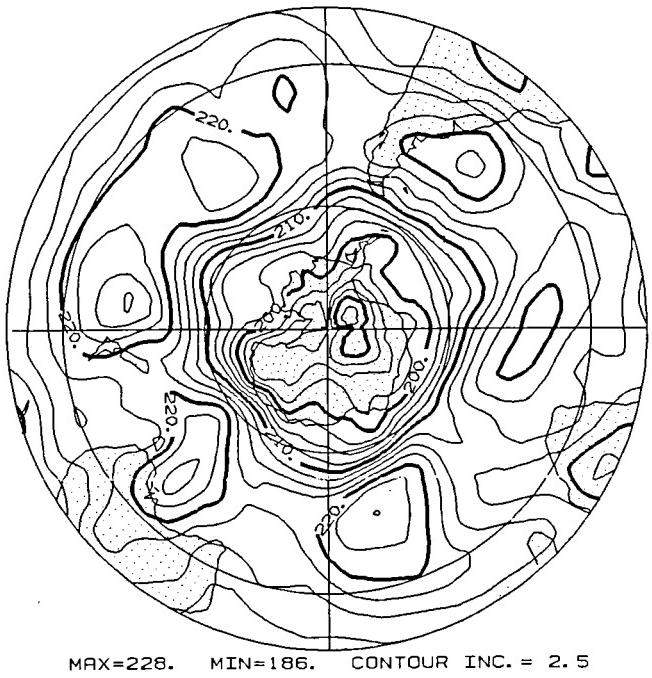


MAX= 519 MIN=-300 CONTOUR INC.=50

NMC 420K ERTEL POT VOR 9/19/87

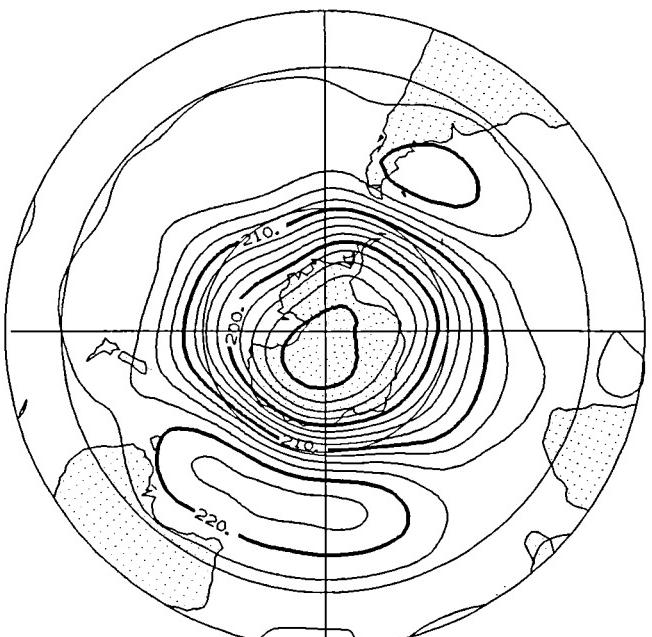


GLA 200-100 THICK. T O 9/19/87



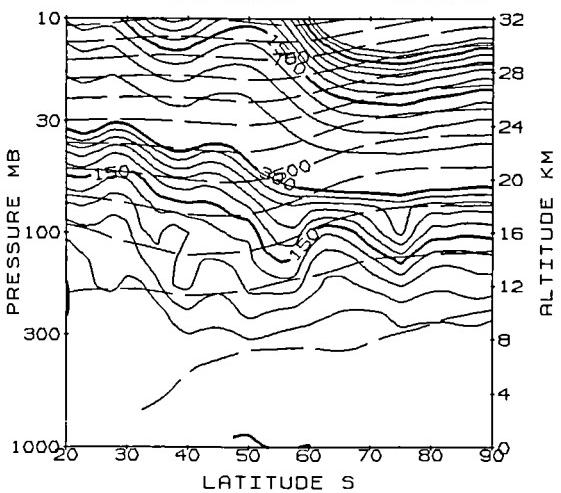
MAX=228. MIN=186. CONTOUR INC. = 2.5

NMC 50-30MB THICKNESS 9/19/87

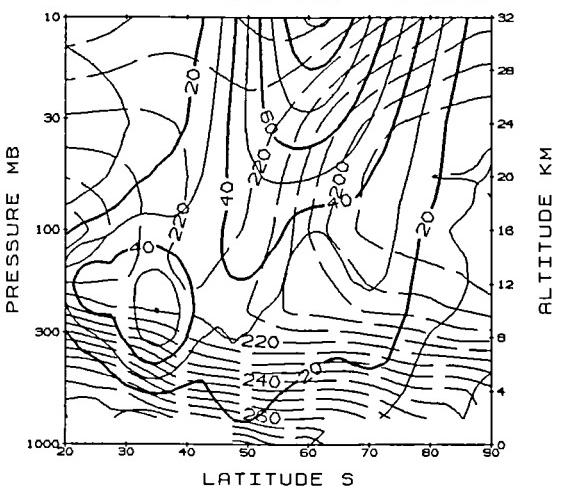


MAX=223. MIN=188. CONTOUR INC. = 2.5

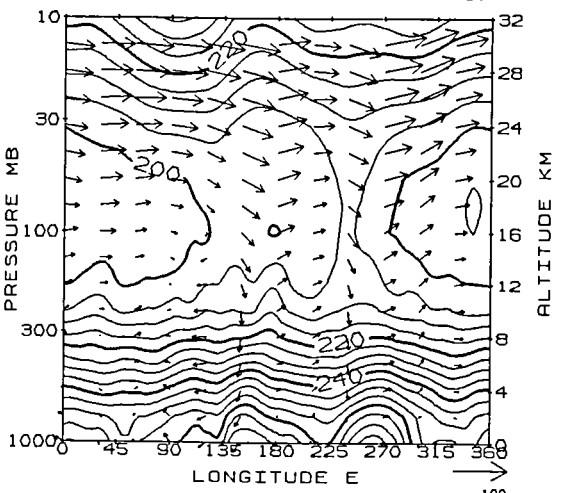
NMC PV AND THETA 9/19/87



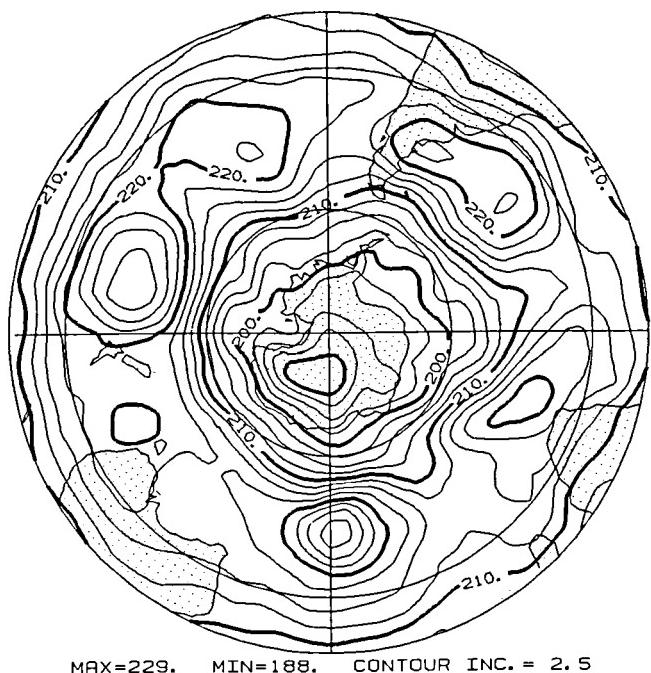
NMC 65W V (M/S) T (K) 9/19/87



NMC 65S TEMP AND WINDS 9/19/87

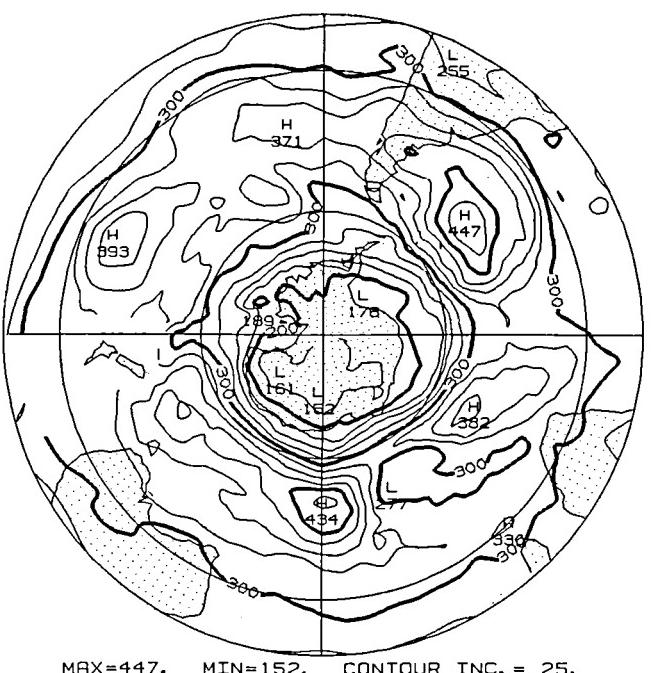


NMC 200-100MB THICKNES 9/20/87



MAX=229. MIN=188. CONTOUR INC. = 2.5

TOMS TOTAL OZONE



MAX=447. MIN=152. CONTOUR INC. = 25.

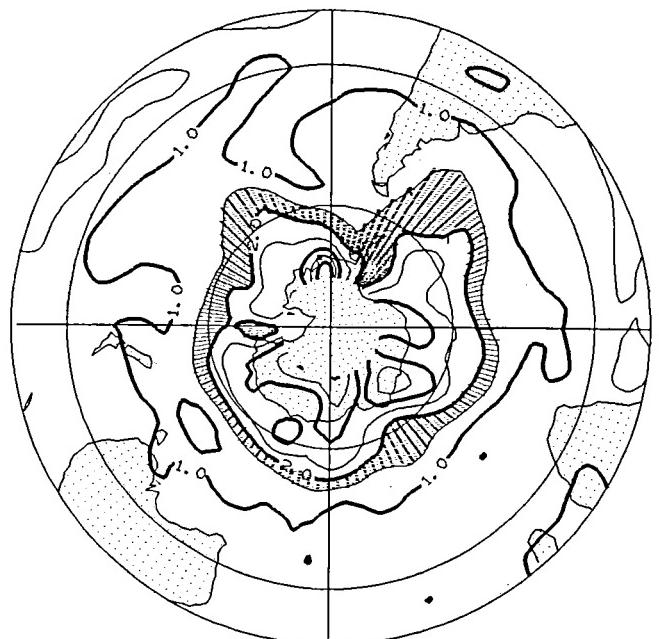
NMC 100MB HGT DEV.

9/20/87



MAX= 531 MIN=-350 CONTOUR INC.=50

NMC 420K ERTEL POT VOR 9/20/87

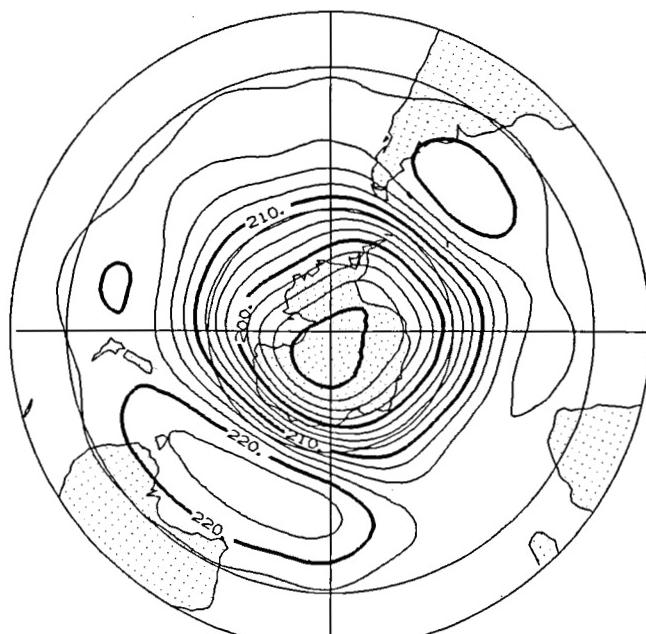


GLA 200-100 THICK. T 0 9/20/87

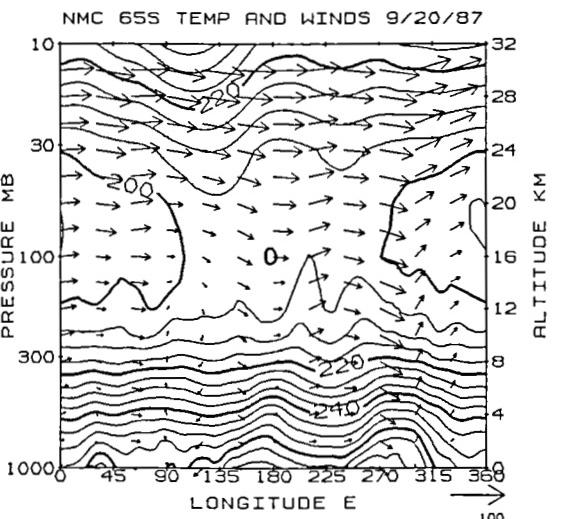
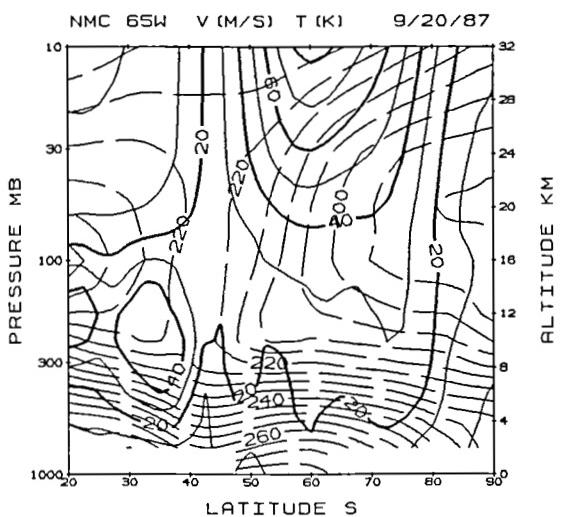
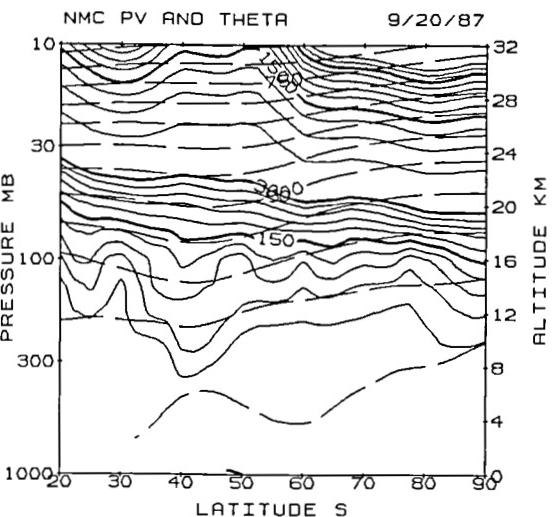


MAX=231. MIN=187. CONTOUR INC. = 2.5

NMC 50-30MB THICKNESS 9/20/87



MAX=224. MIN=188. CONTOUR INC. = 2.5

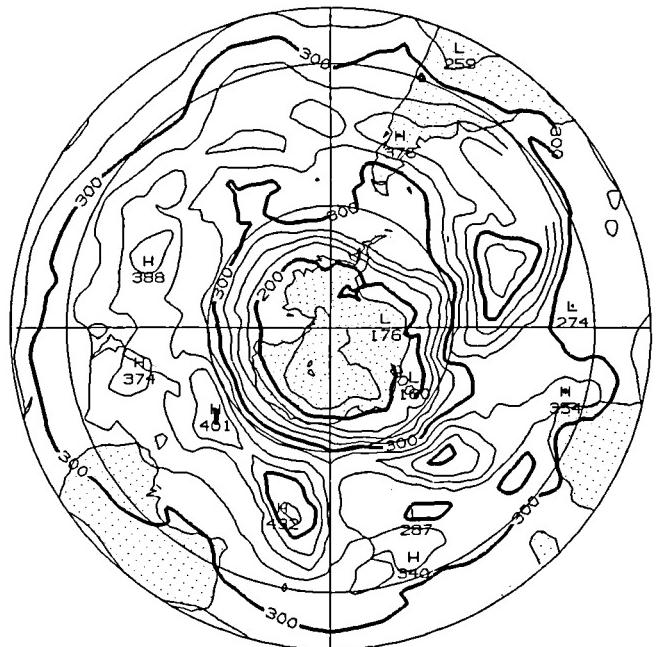


NMC 200-100MB THICKNES 9/21/87



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TOMS TOTAL OZONE



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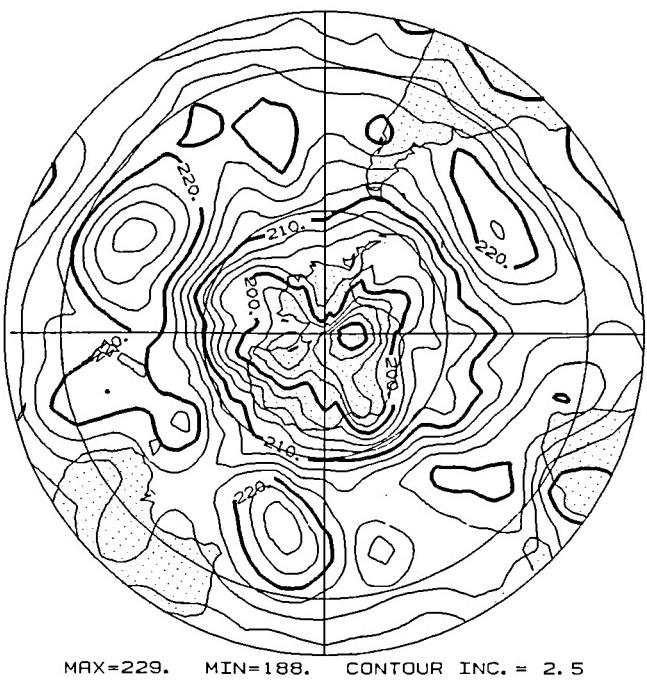


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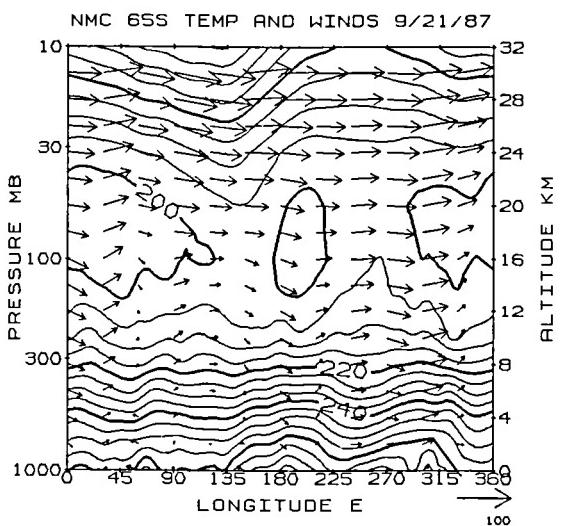
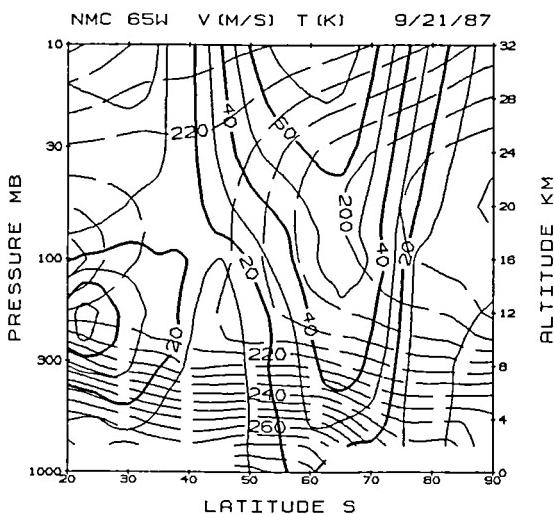
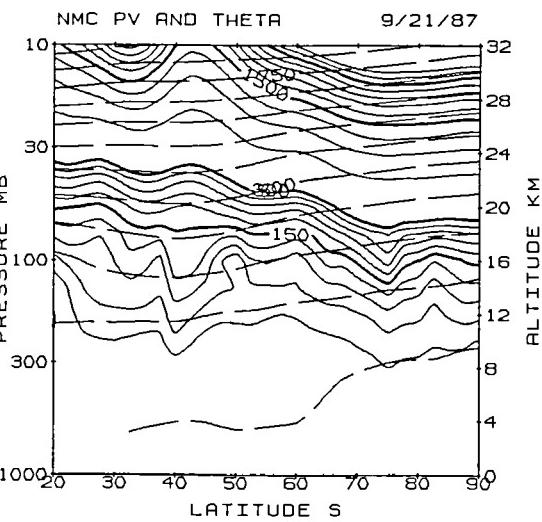
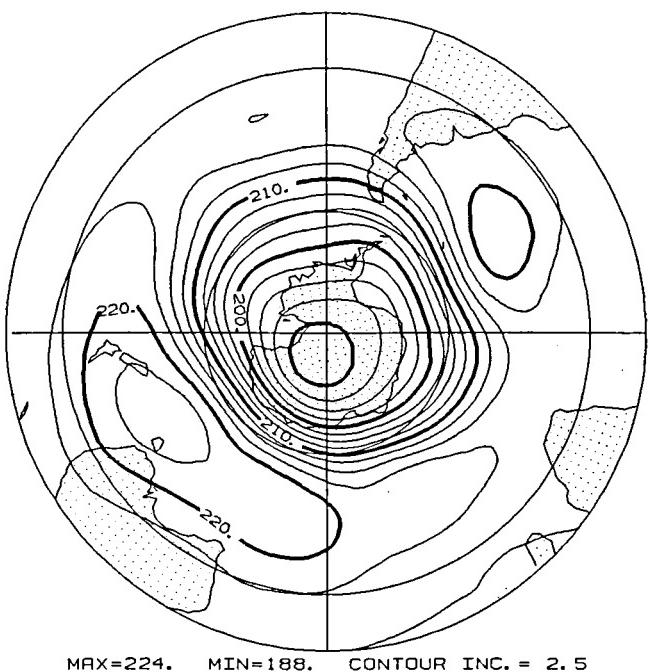
NMC 420K ERTEL POT VOR 9/21/87



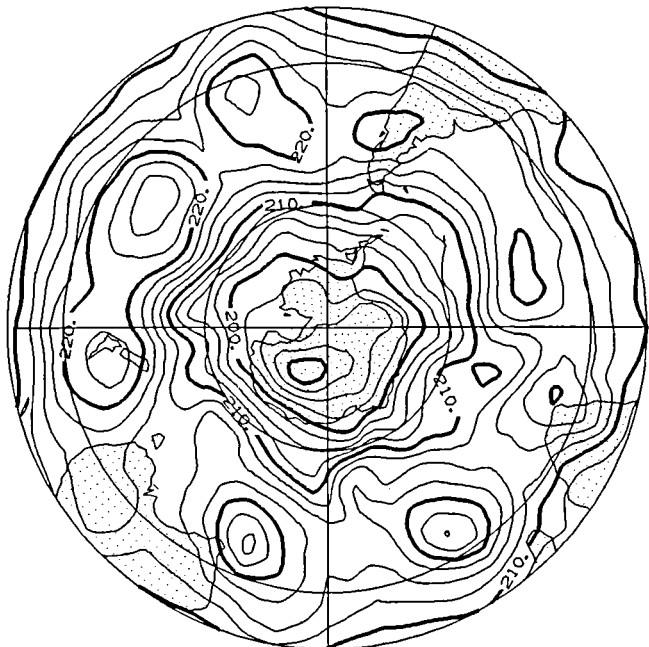
GLA 200-100 THICK. T 0 9/21/87



NMC 50-30MB THICKNESS 9/21/87

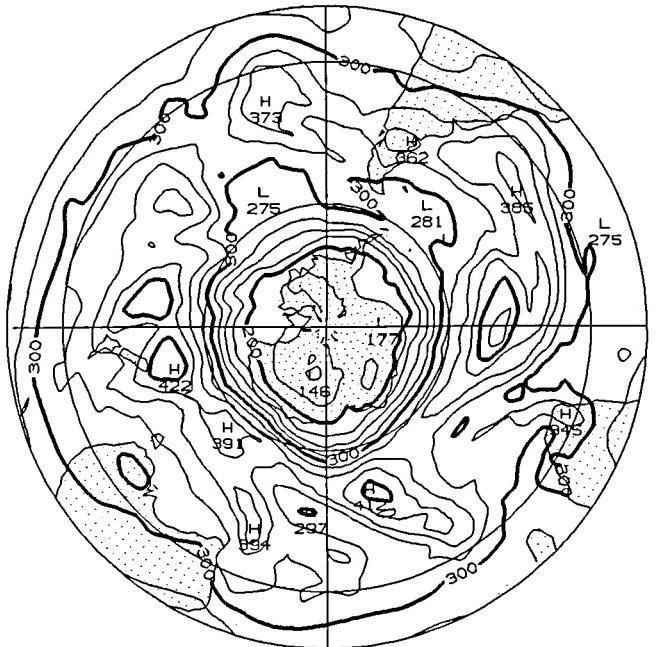


NMC 200-100MB THICKNES 9/22/87



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TOMS TOTAL OZONE



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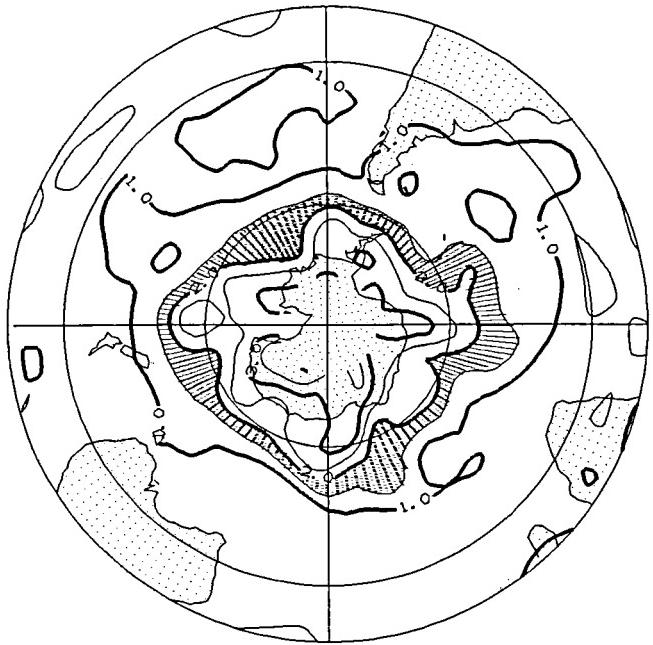
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9/22/87

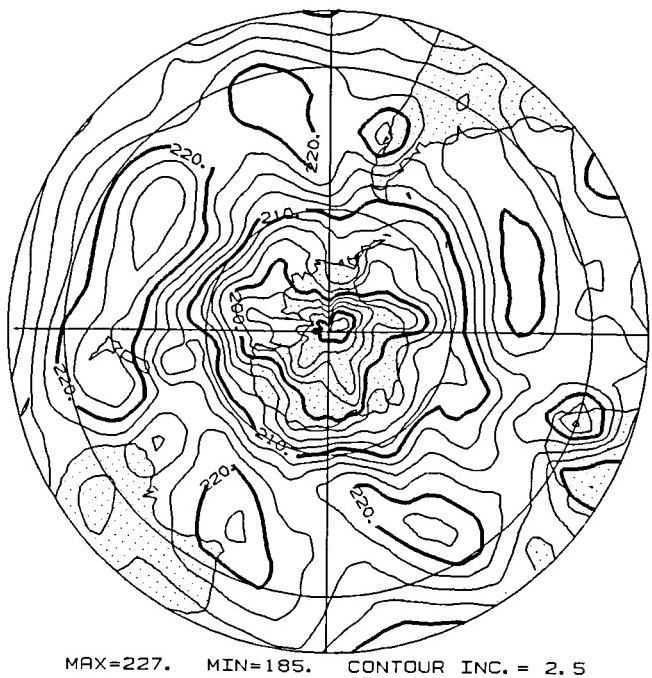


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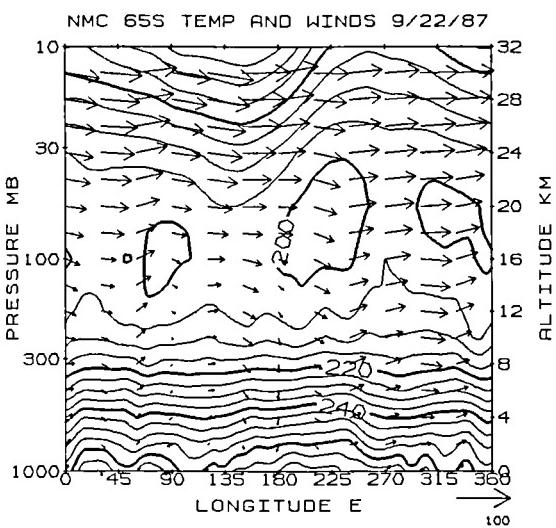
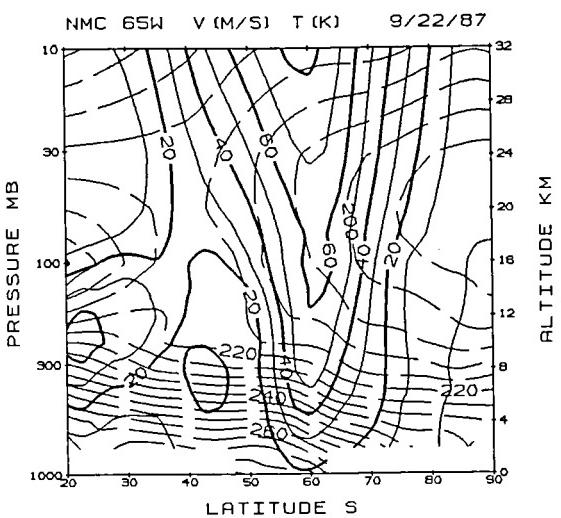
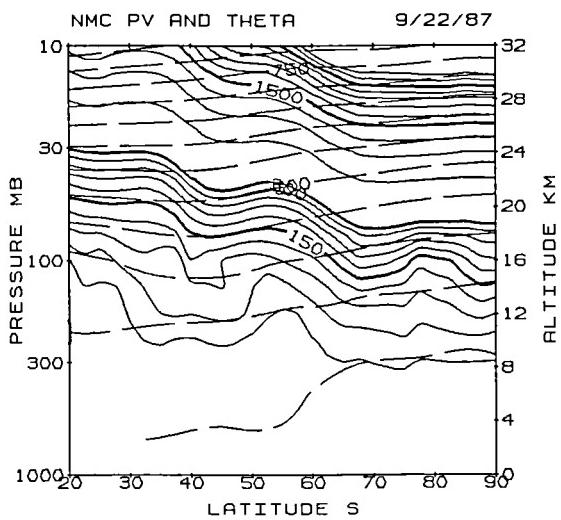
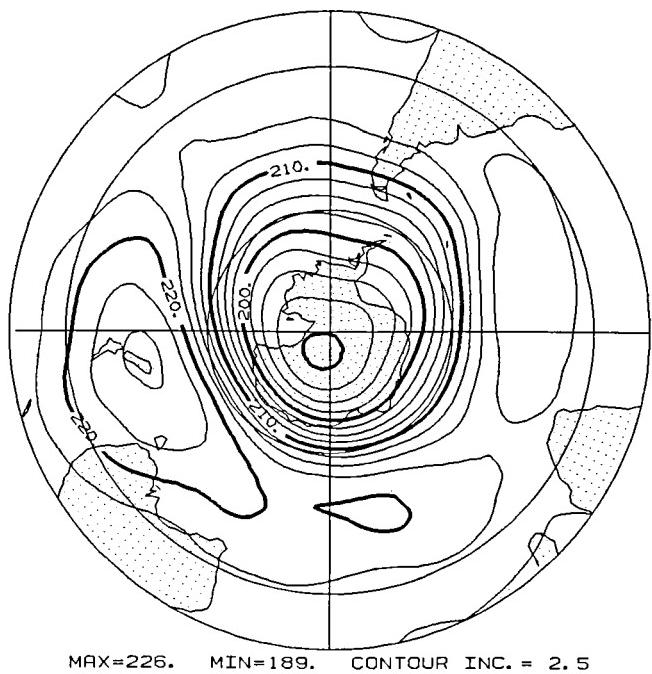
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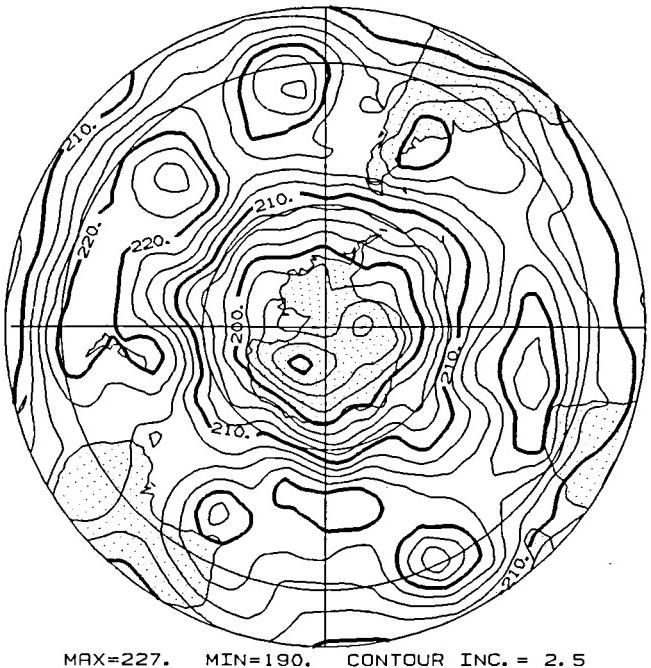
GLA 200-100 THICK. T O 9/22/87



NMC 50-30MB THICKNESS 9/22/87



NMC 200-100MB THICKNES 9/23/87



MAX=227. MIN=190. CONTOUR INC. = 2.5

TOMS TOTAL OZONE



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NMC 100MB HGT DEV.

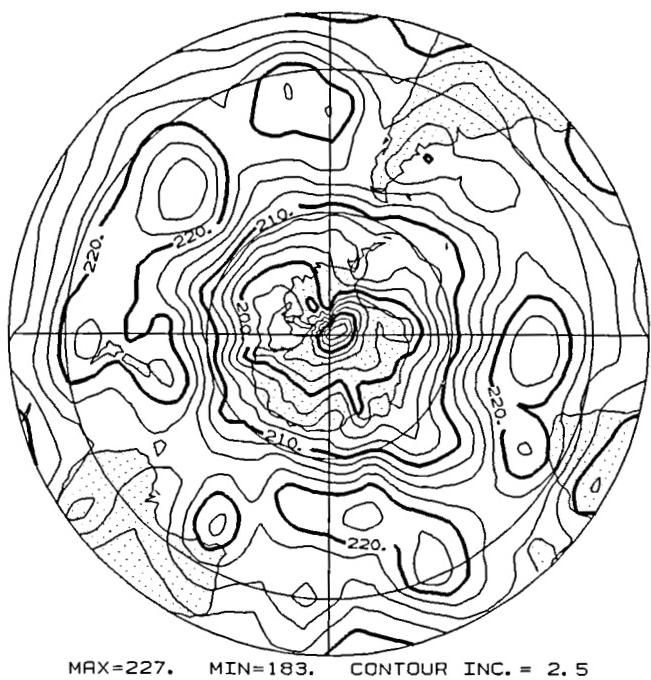


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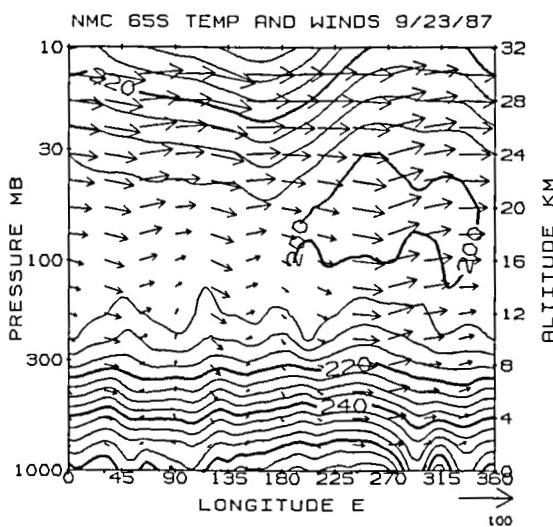
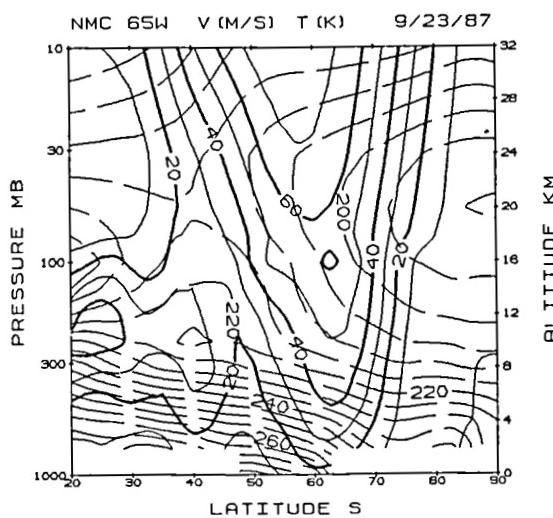
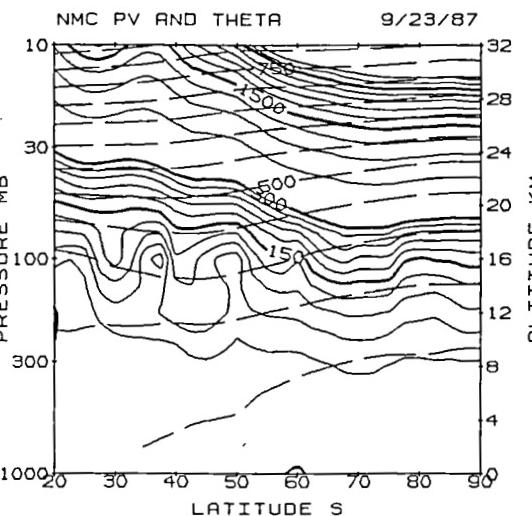
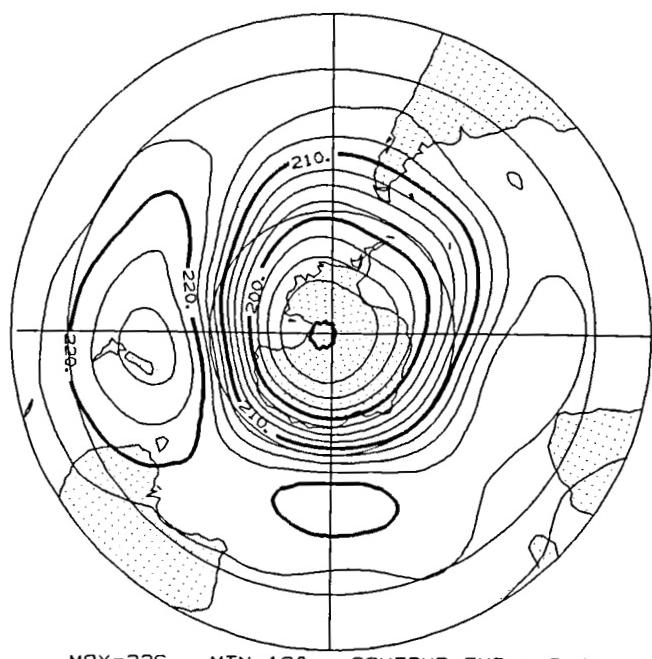
NMC 420K ERTEL POT VOR 9/23/87



GLA 200-100 THICK. T 0 9/23/87



NMC 50-30MB THICKNESS 9/23/87

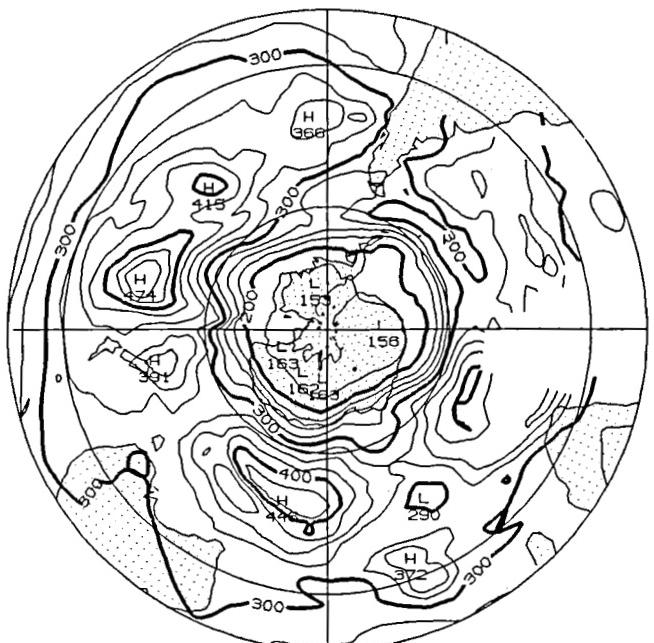


NMC 200-100MB THICKNES 9/24/87



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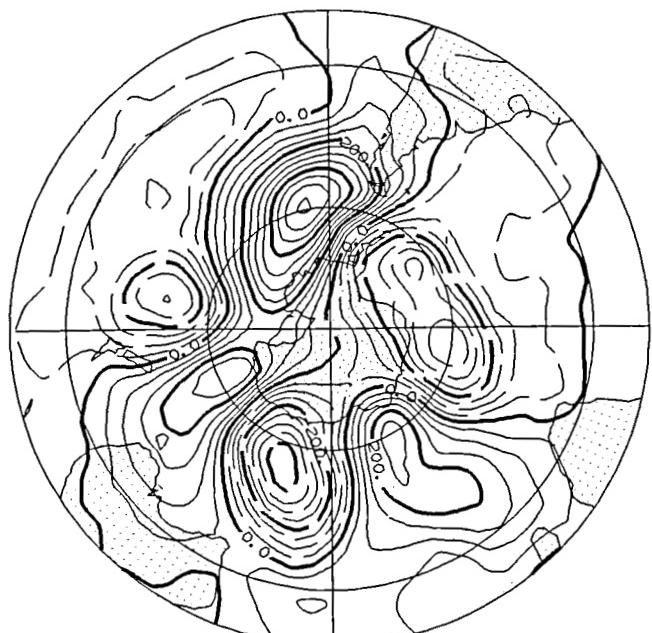
TOMS TOTAL OZONE



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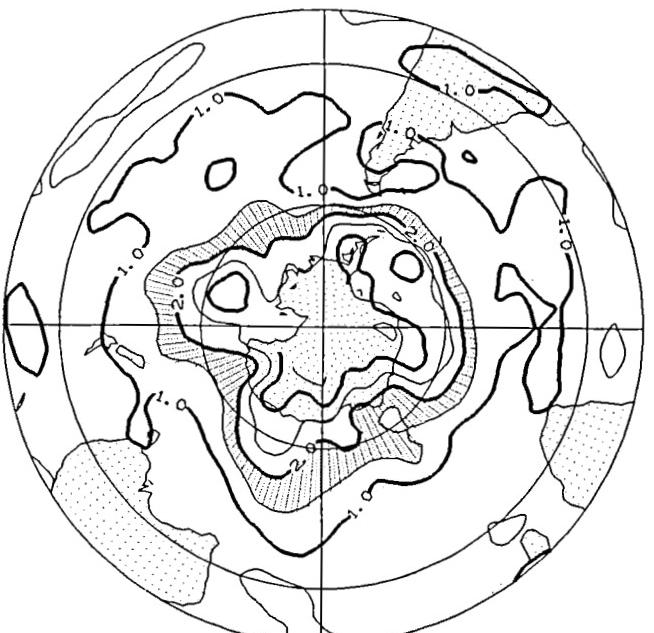
NMC 100MB HGT DEV.

9/24/87

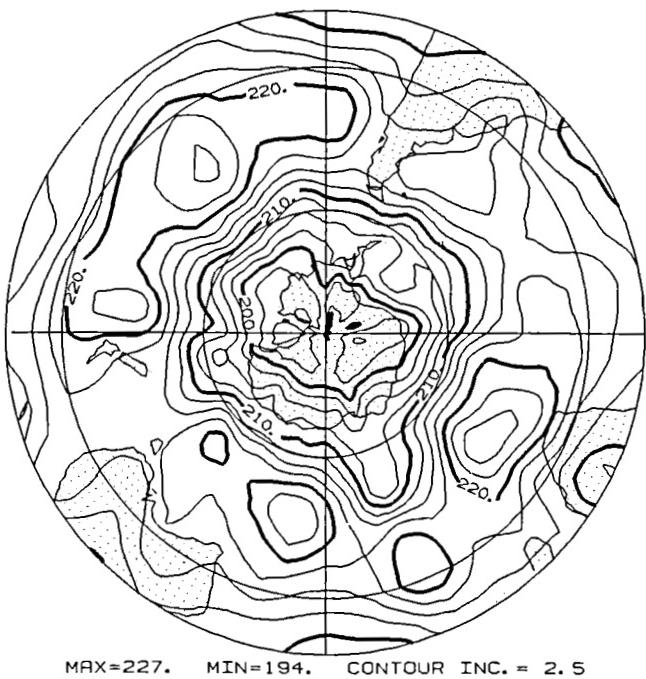


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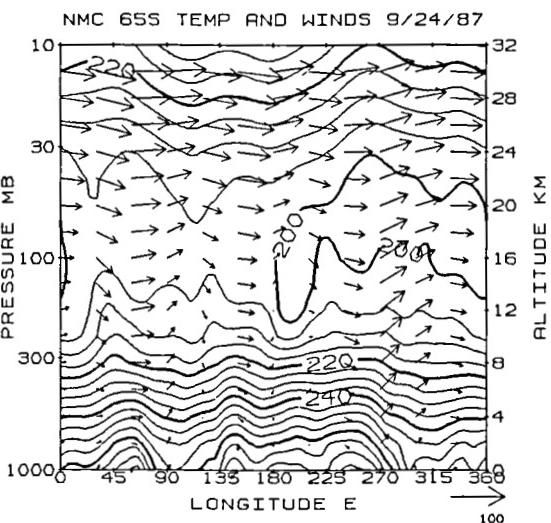
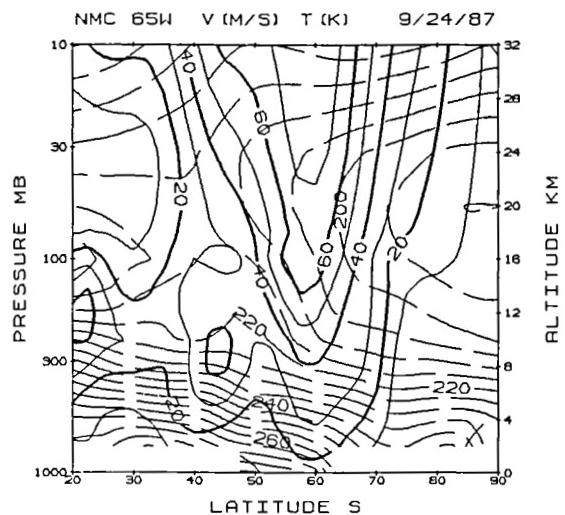
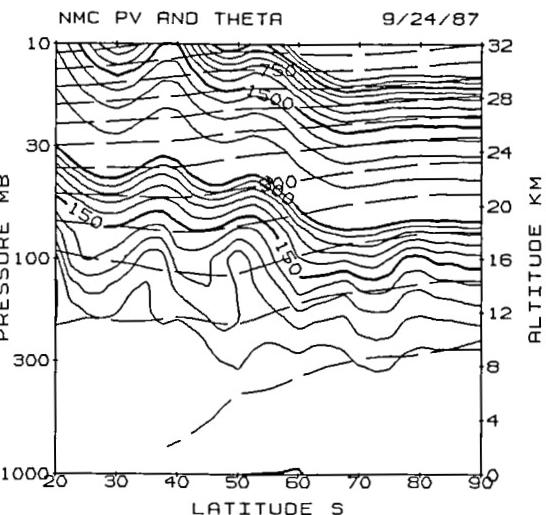
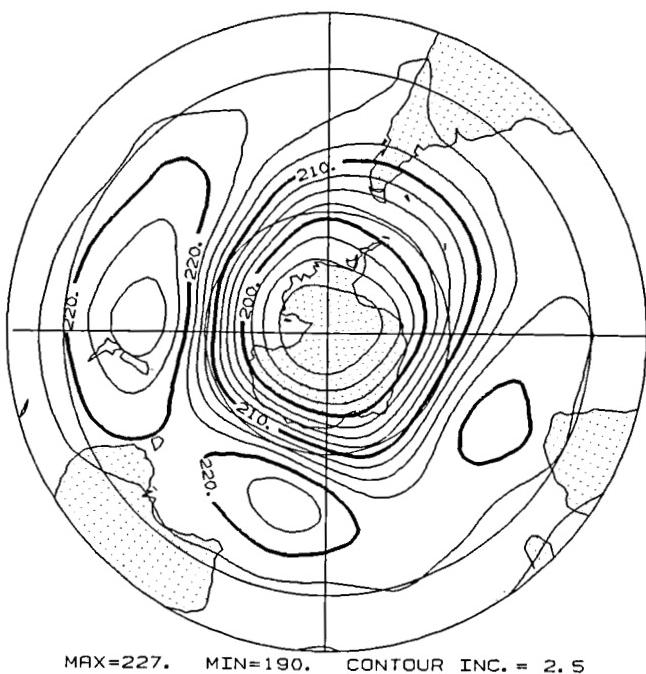
NMC 420K ERTEL POT VOR 9/24/87



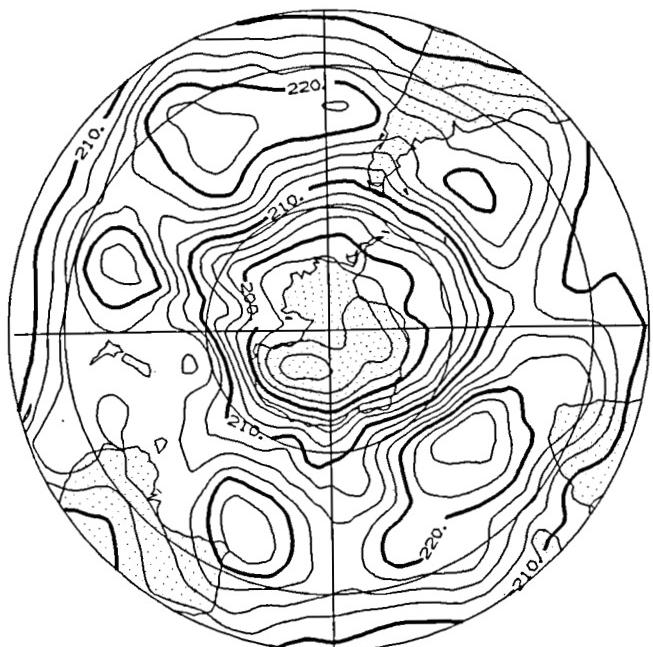
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NMC 50-30MB THICKNESS 9/24/87

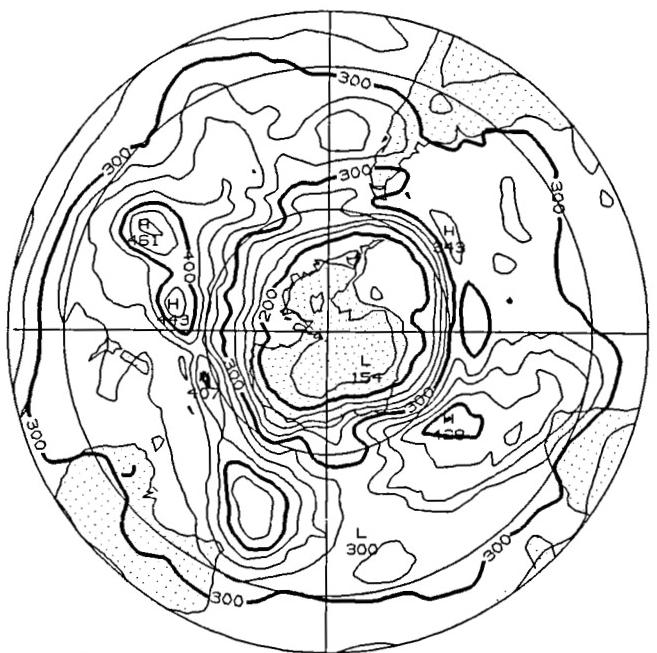


NMC 200-100MB THICKNES 9/25/87



MAX=227. MIN=191. CONTOUR INC. = 2.5

TOMS TOTAL OZONE



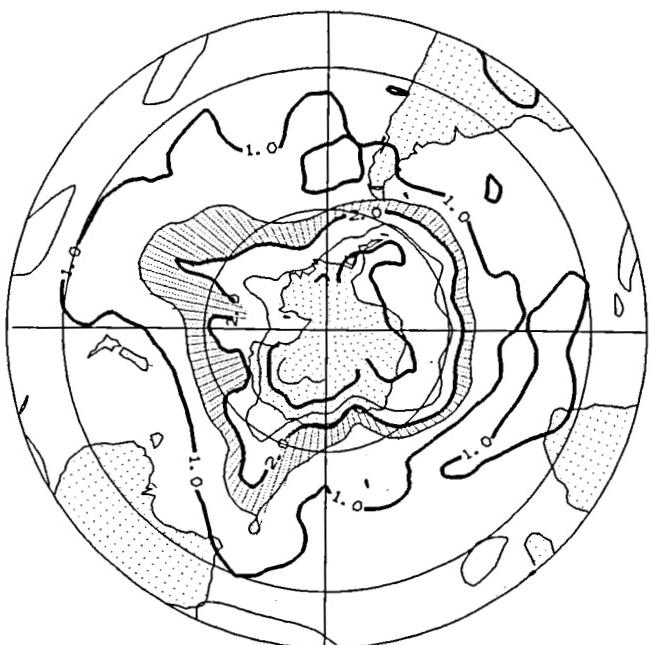
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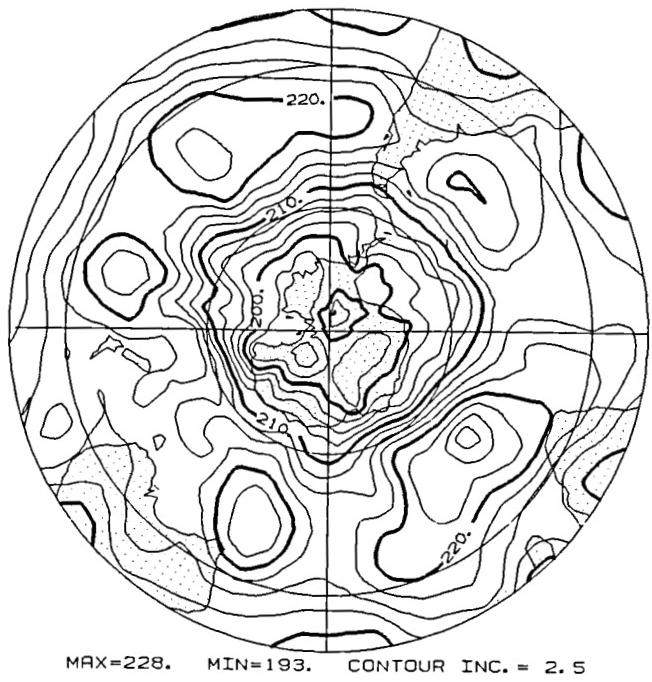


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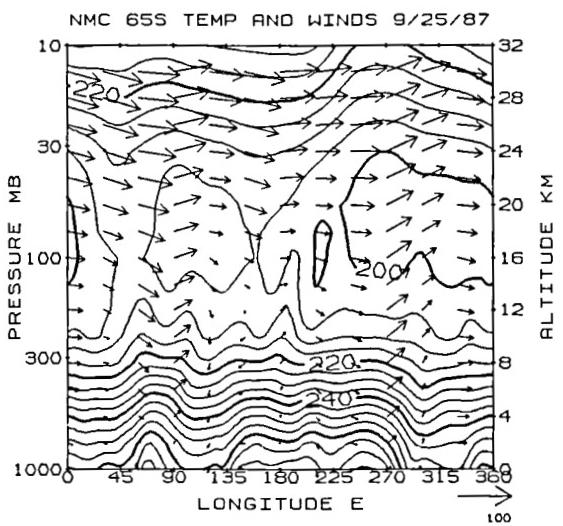
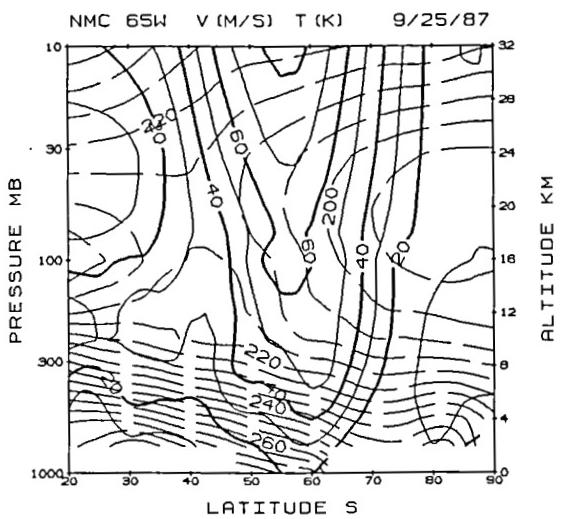
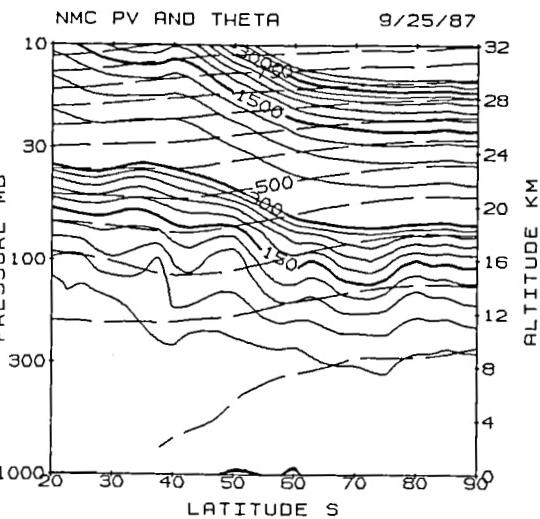
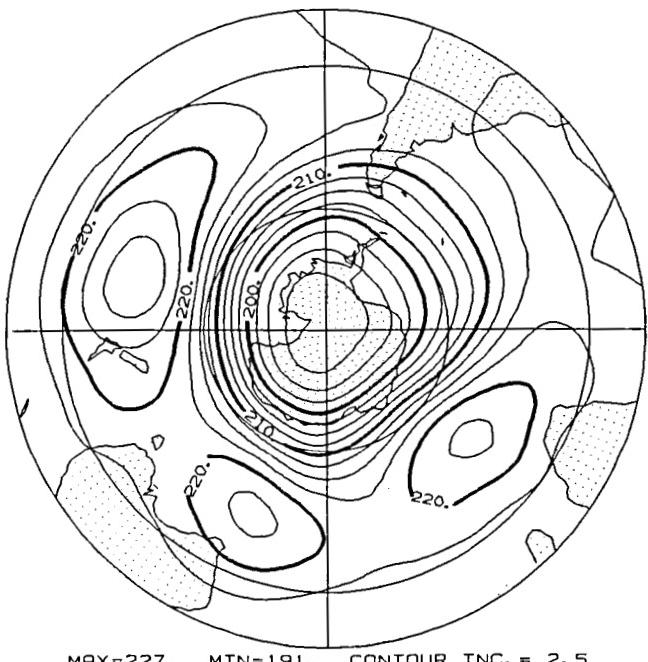
NMC 420K ERTEL POT VOR 9/25/87



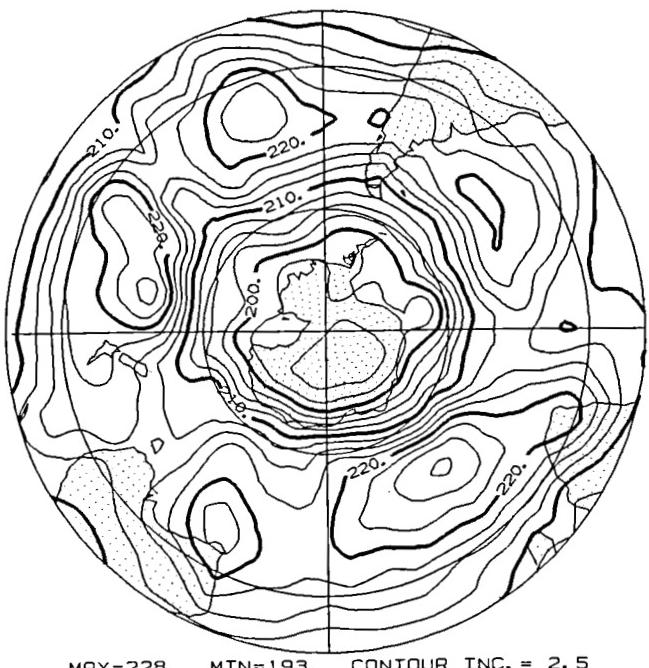
GLA 200-100 THICK. T O 9/25/87



NMC 50-30MB THICKNESS 9/25/87

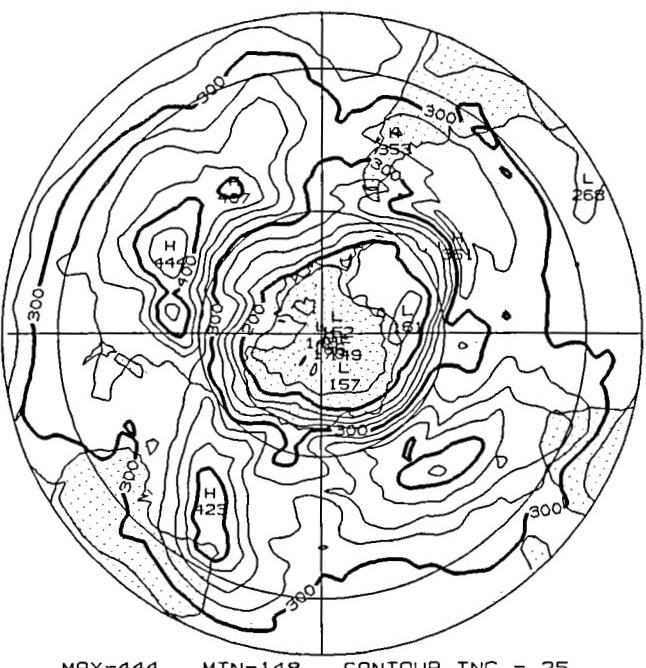


NMC 200-100MB THICKNES 9/26/87



MAX=228. MIN=193. CONTOUR INC. = 2.5

TOMS TOTAL OZONE



MAX=444. MIN=148. CONTOUR INC. = 25.

NMC 100MB HGT DEV.

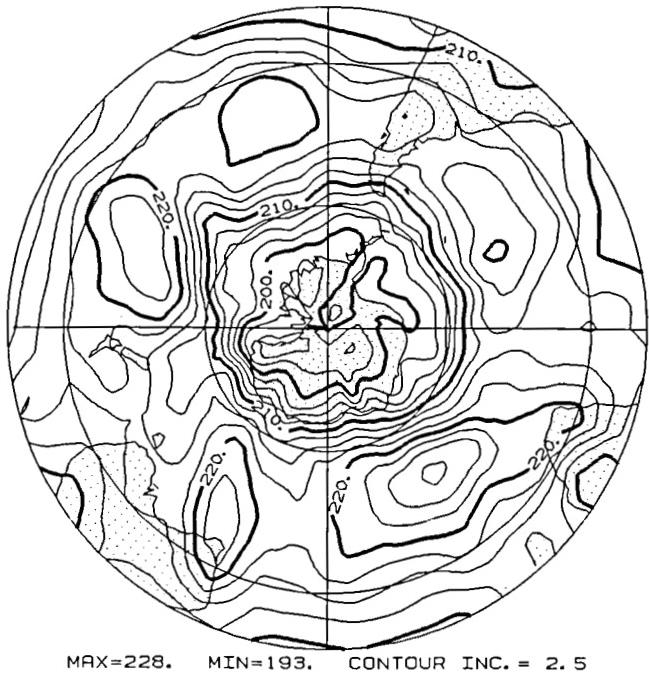


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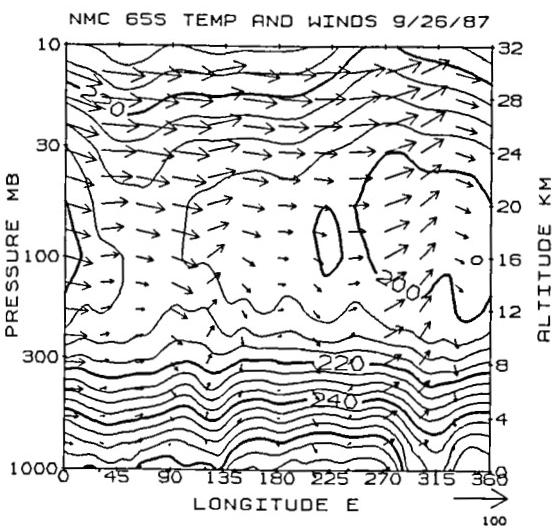
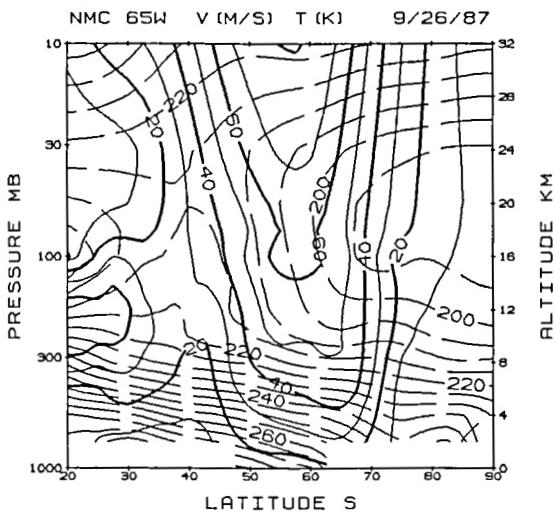
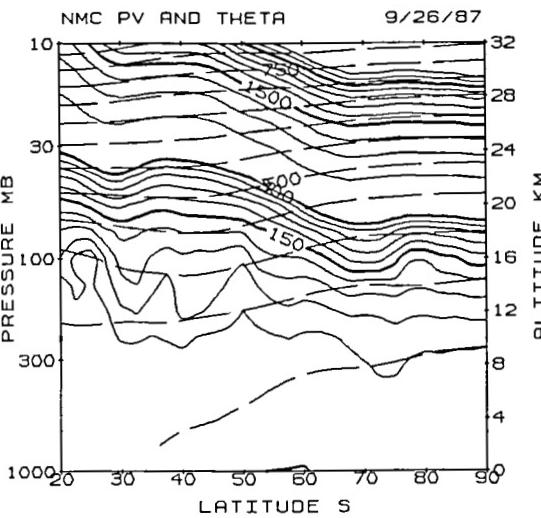
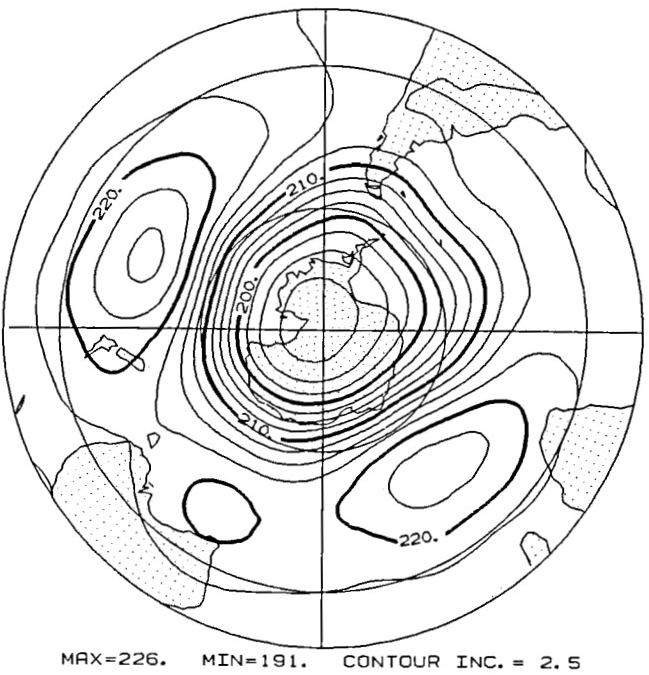
NMC 420K ERTEL POT VOR 9/26/87



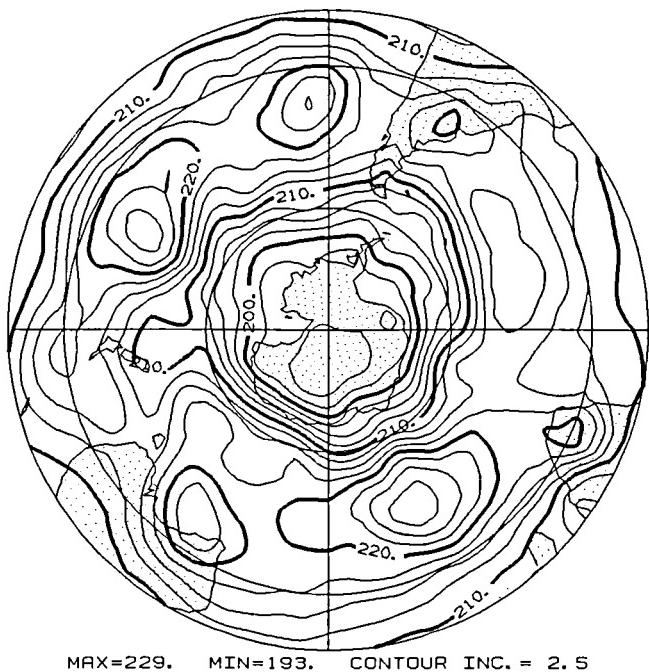
GLA 200-100 THICK. T O 9/26/87



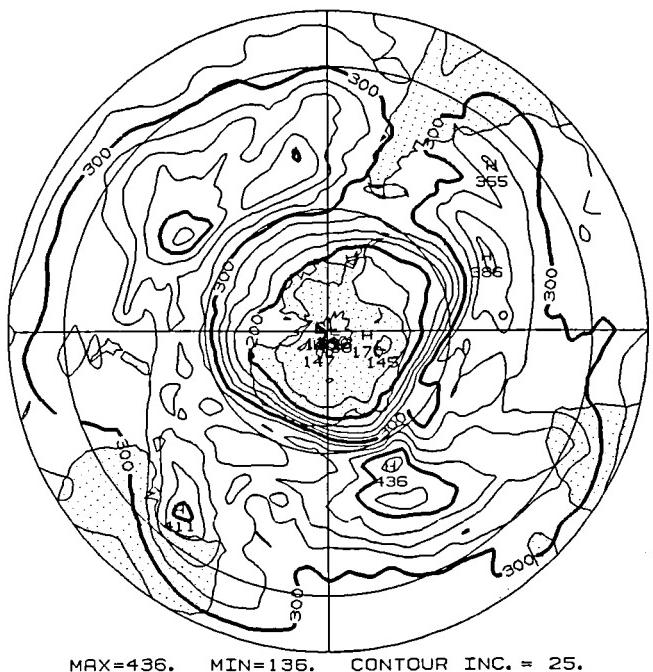
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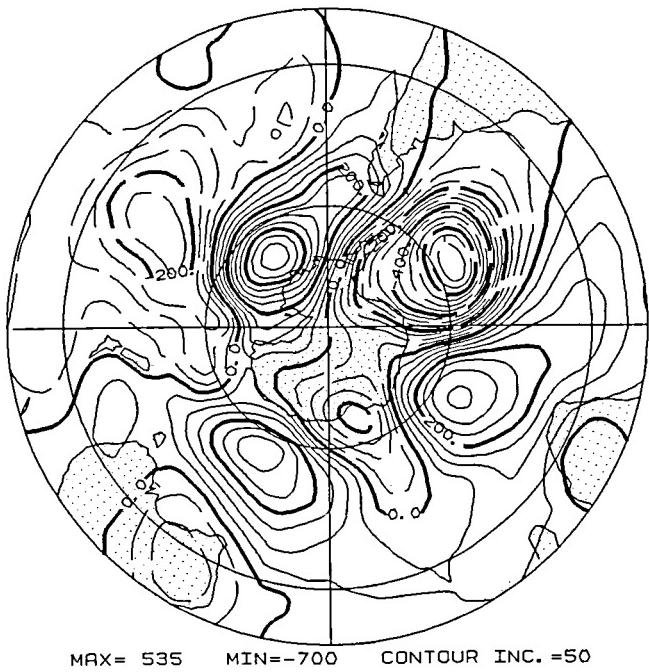
NMC 200-100MB THICKNES 9/27/87



TOMS TOTAL OZONE



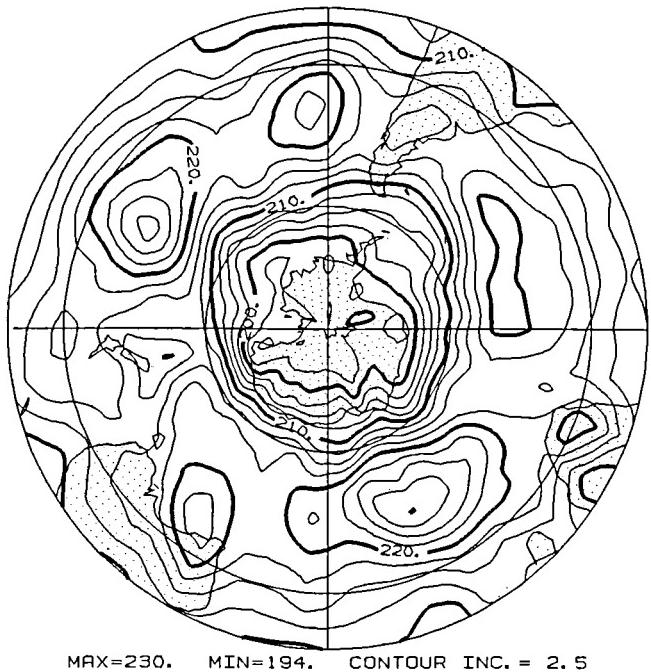
NMC 100MB HGT DEV. 9/27/87



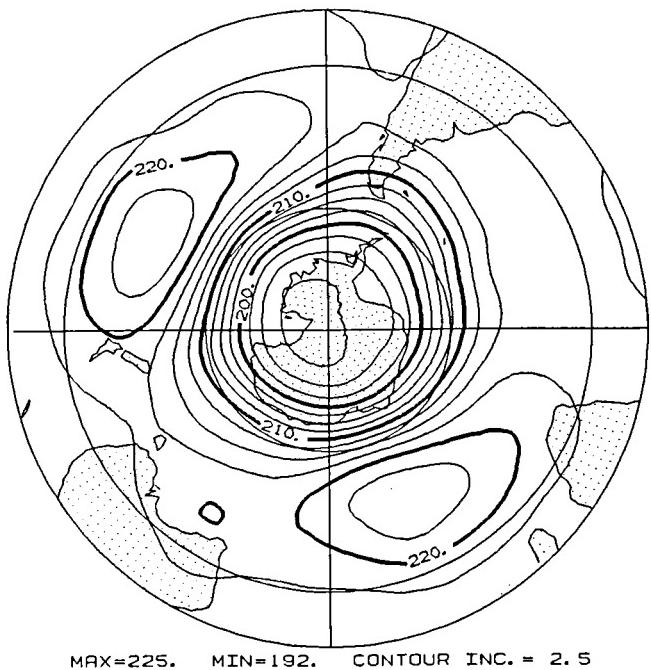
NMC 420K ERTEL POT VOR 9/27/87



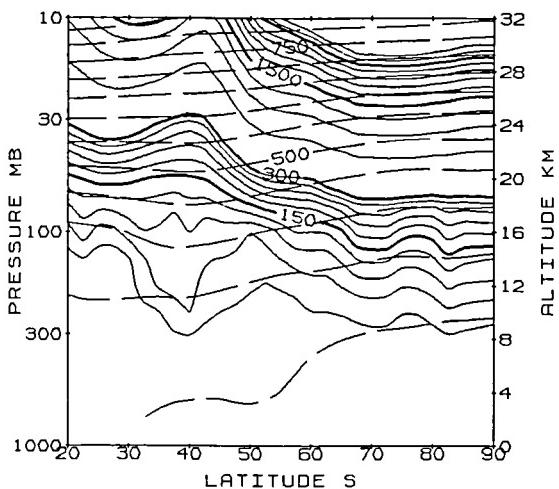
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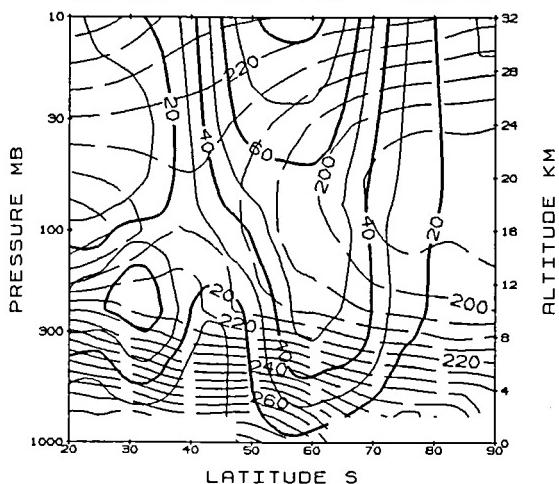
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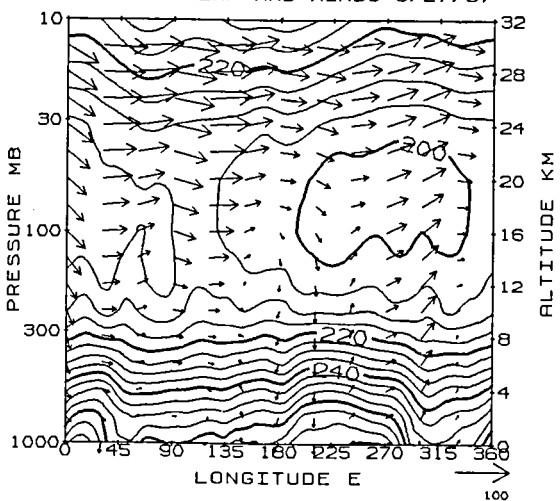
NMC PV AND THETA 9/27/87



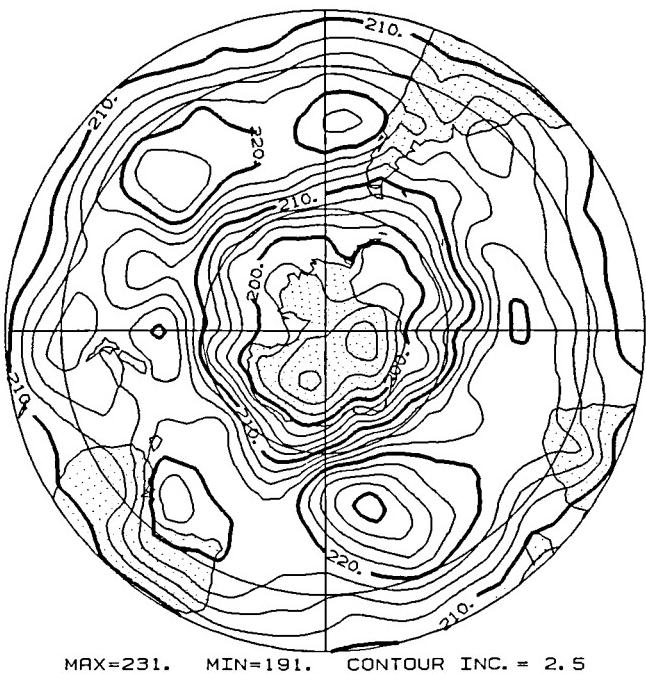
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NMC 65S TEMP AND WINDS 9/27/87

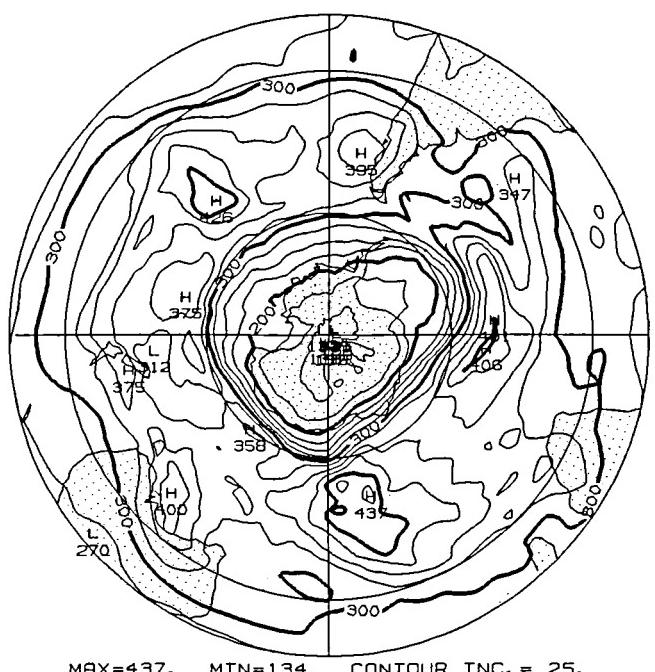


NMC 200-100MB THICKNES 9/28/87



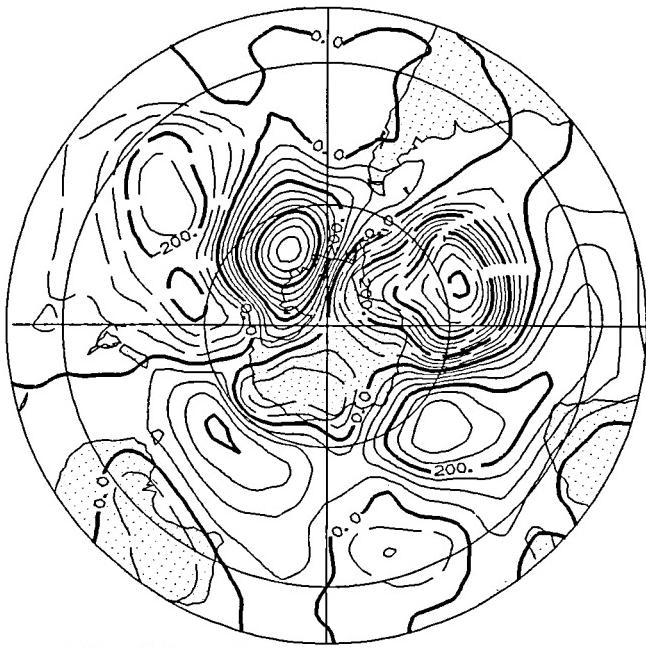
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TOMS TOTAL OZONE



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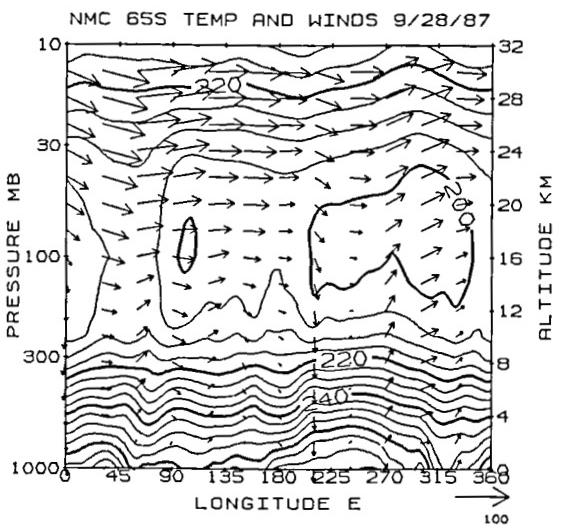
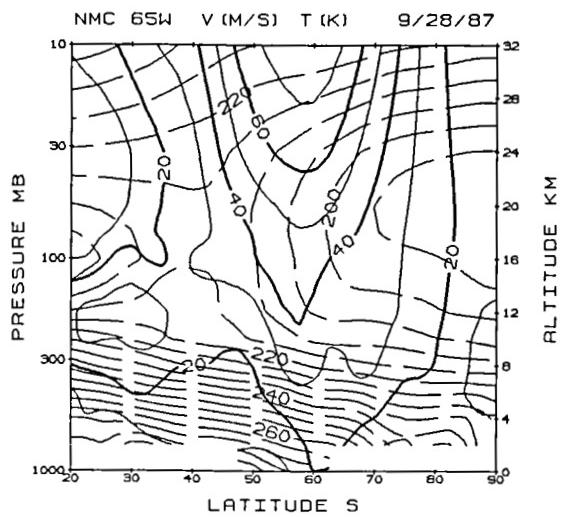
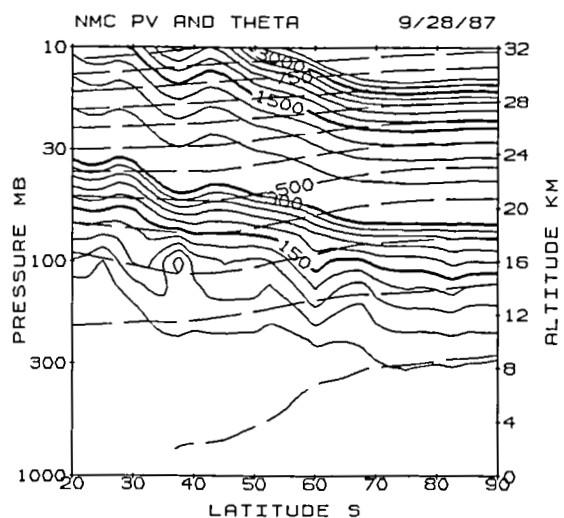
NMC 100MB HGT DEV.



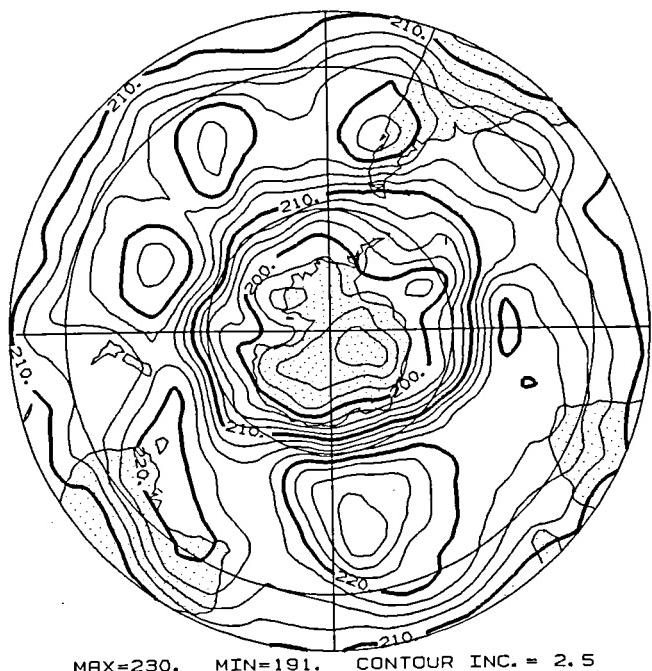
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NMC 420K ERTEL POT VOR 9/28/87

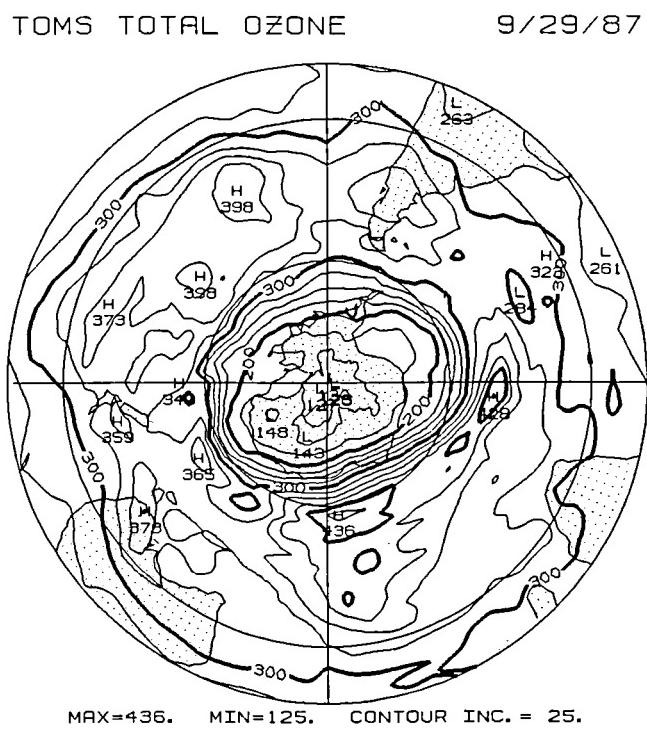




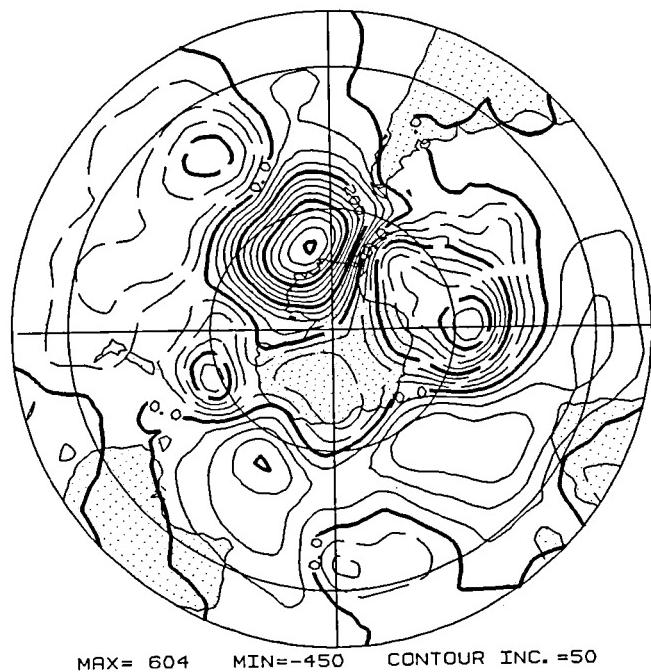
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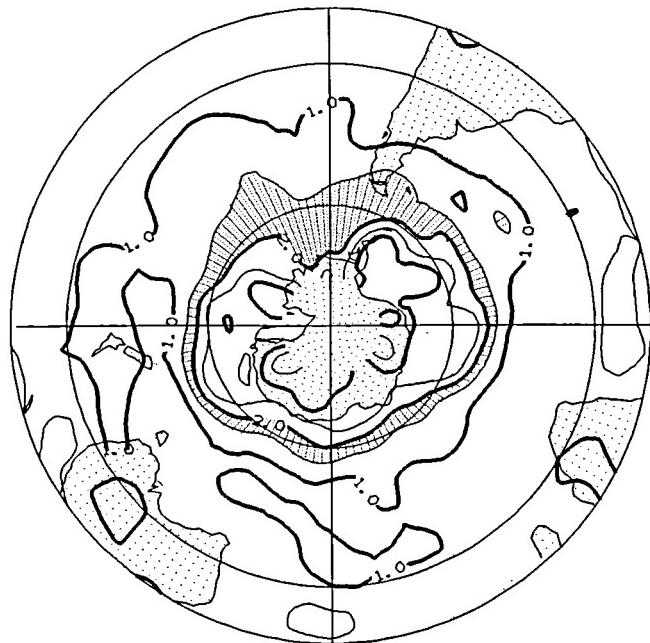
TOMS TOTAL OZONE

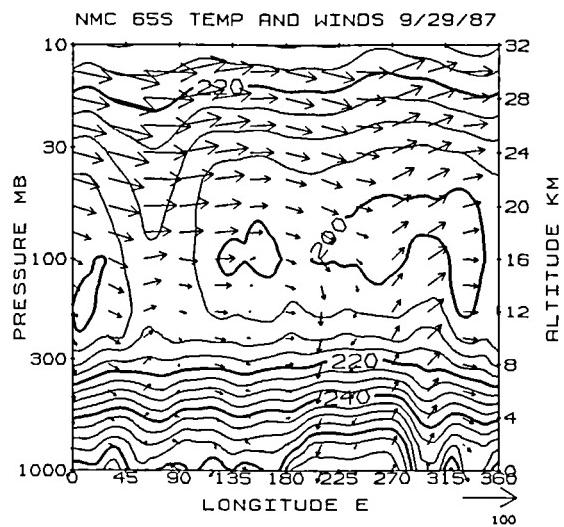
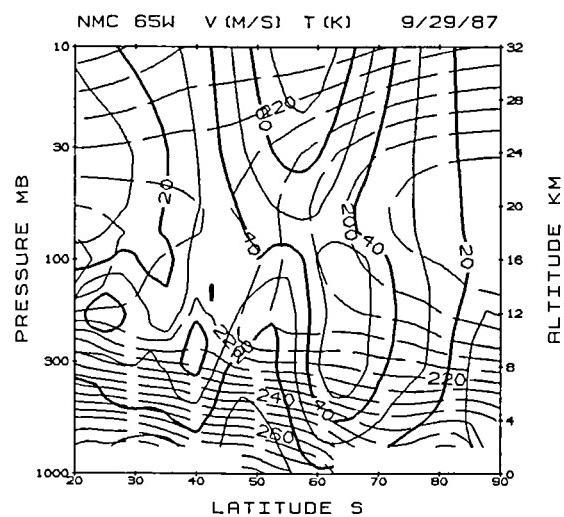
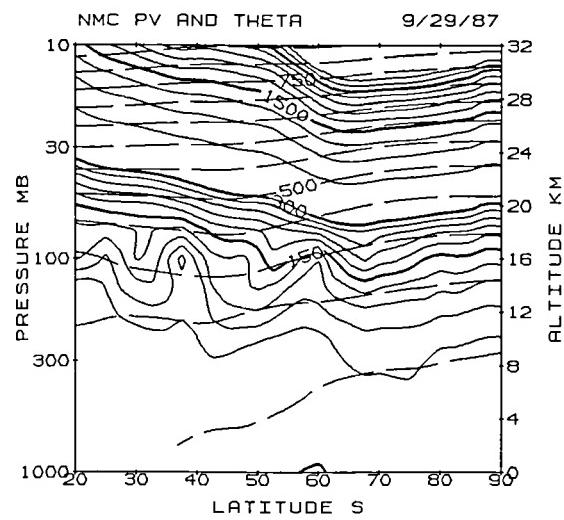
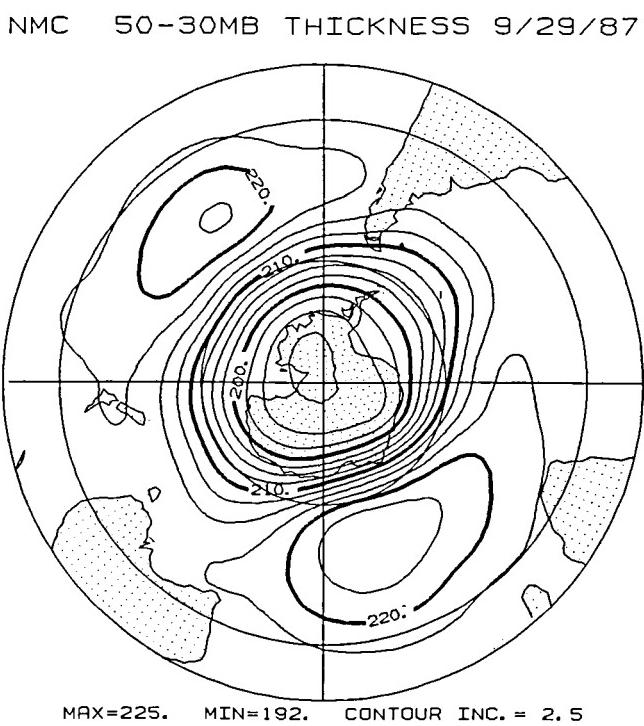


NMC 100MB HGT DEV.

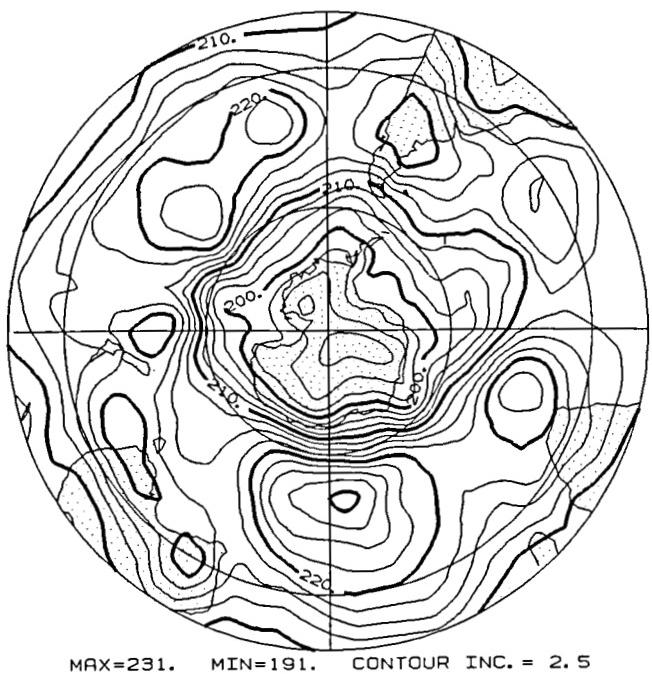


NMC 420K ERTEL POT VOR 9/29/87



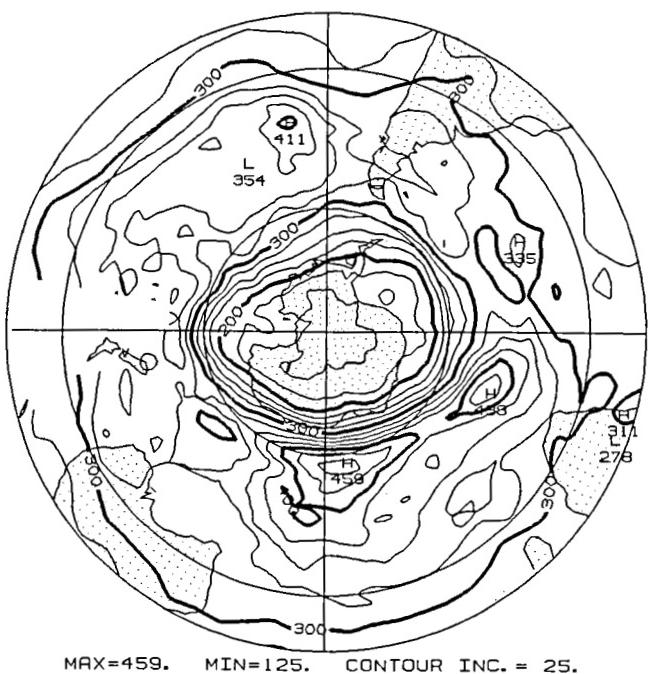


NMC 200-100MB THICKNES 9/30/87



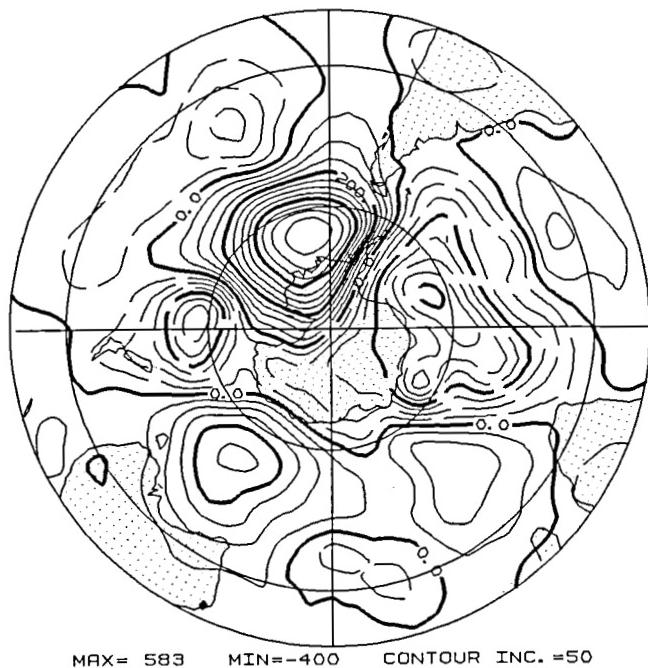
TOMS TOTAL OZONE

9/30/87

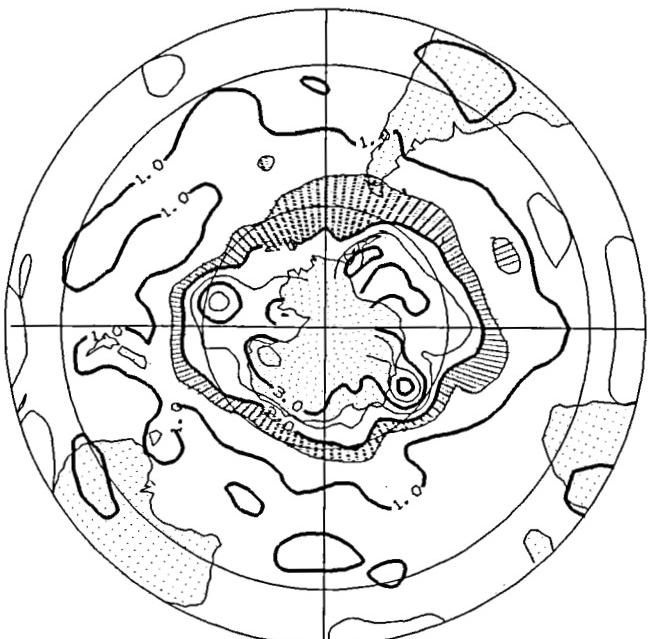


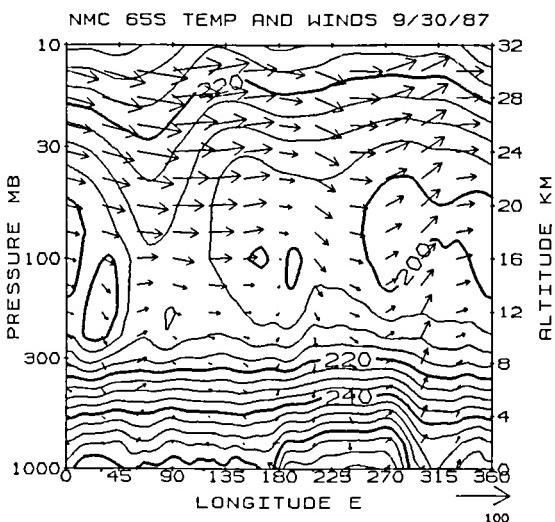
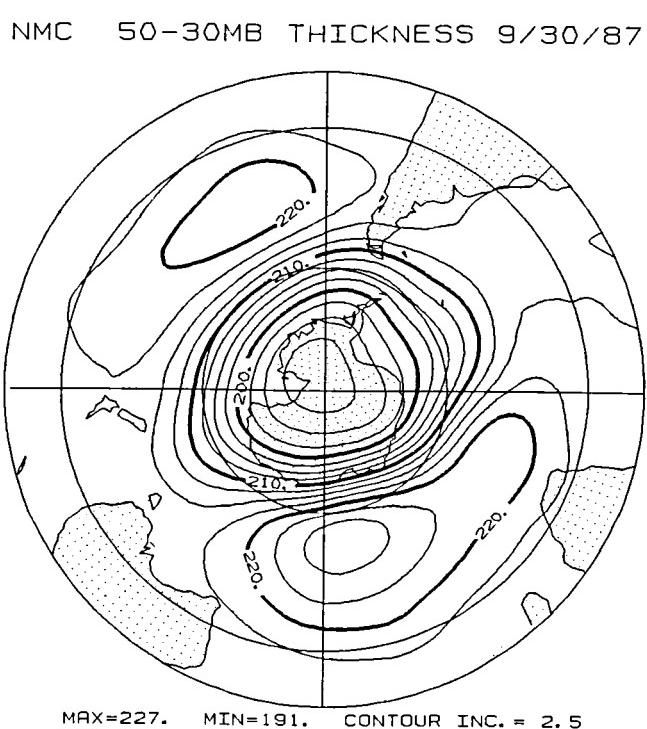
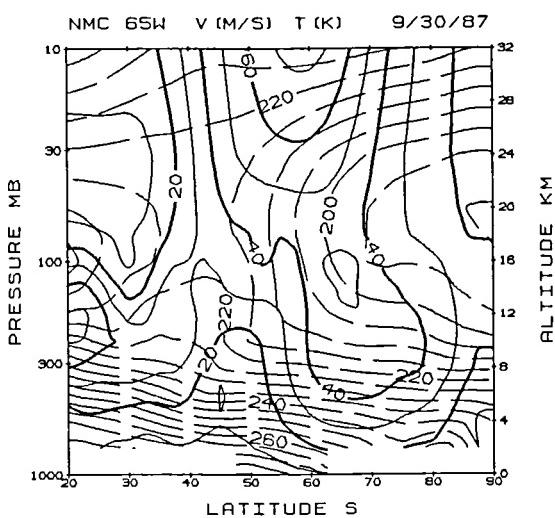
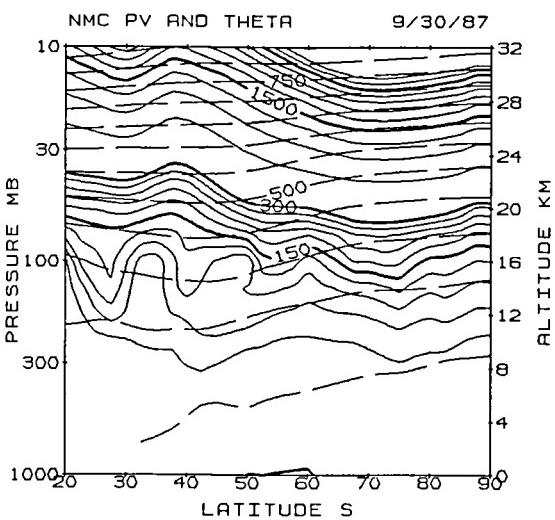
NMC 100MB HGT DEV.

9/30/87



NMC 420K ERTEL POT VOR 9/30/87







## Report Documentation Page

|  |  |   |                      |
|--|--|---|----------------------|
| 1. Report No.<br><br>NASA TM-4049  | 2. Government Accession No.                              | 3. Recipient's Catalog No.  |                      |
| 4. Title and Subtitle<br><br>METEOROLOGICAL ATLAS OF THE SOUTHERN HEMISPHERE<br>LOWER STRATOSPHERE FOR AUGUST AND SEPTEMBER 1987   |  | 5. Report Date<br><br>June 1988   |                      |
|  |  | 6. Performing Organization Code<br><br>616.0  |                      |
| 7. Author(s)<br><br>P. A. Newman, D. J. Lamich, M. Gelman, M. R. Schoeberl,<br>W. Baker, and A. J. Krueger   |  | 8. Performing Organization Report No.<br><br>88P0189                                  |                      |
|  |  | 10. Work Unit No.   |                      |
| 9. Performing Organization Name and Address<br><br>Goddard Space Flight Center<br>Greenbelt, Maryland 20771  |  | 11. Contract or Grant No.   |                      |
|  |  | 13. Type of Report and Period Covered<br><br>Technical Memorandum                     |                      |
| 12. Sponsoring Agency Name and Address<br><br>National Aeronautics and Space Administration<br>Washington, D.C. 20546-0001   |  | 14. Sponsoring Agency Code  |                      |
| 15. Supplementary Notes<br><br>P. A. Newman: Applied Research Corporation, Landover, Maryland.<br>D. J. Lamich: Sigma Data Services Corporation, Rockville, Maryland.<br>M. Gelman: National Meteorological Center, Washington, D.C.<br>M. R. Schoeberl, W. Baker, A. J. Krueger: Goddard Space Flight Center, Greenbelt, Maryland.  |  |   |                      |
| 16. Abstract<br><br>Southern hemisphere meteorological data for the months of August and September 1987 in the lower stratosphere are shown. National Meteorological Center (NMC) data, Total Ozone Mapping Spectrometer (TOMS) data, and Goddard Laboratory for Atmospheres (GLA) data are used to display polar stereographic projections of 200-100mb vertical mean temperatures, 100mb zonal mean geopotential height perturbations, total ozone, Ertel's potential vorticity (Epv), and 50-30mb vertical mean temperatures. In addition, latitude/height cross sections at 65 W of potential temperature, Epv, geostrophic isotachs, and temperature are also shown. Finally, a longitude/height cross section at 65 S of temperature and geostrophic wind vectors is also shown. |  |   |                      |
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